NATURE

Vol. 141 SATURDAY, FEBRUARY 5, 1938 No. 3562

CONTENTS

	PAGE
Science in Administration	219
Origins and Growth of Chemistry. By Dr. E. J. Holmyard	221
Archæology in South Africa. By Dr. D. Randall-MacIver	222
The Presentation of Applied Physics	224
Analysis of Animal Foods. By A. L. B.	225
Iodine. By Prof. Irvine Masson	227
Scientific Research in India. From a Correspondent	230
The Aurora of January 25-26	232
Obituary Notices:	
Prof. W. H. Pickering. By F. W. D.	235
News and Views	236
Letters to the Editor:	
Light Scattering and Fluid Viscosity.—Sir C. V. Raman, F.R.S. and B. V. Raghavendra Rao	242
New Phenomena Connected with Heat Flow in Helium II.—J. F. Allen and H. Jones	243
Memories of Rutherford in Manchester.—Prof. H. Geiger	244
Relativistic Stark Effect of Ionized Helium.—Dr. B. Kullenberg	244
Bode's Law and Saturn's Satellites.—J. Miller	245
Methods of Estimating Mental Factors.—Prof. Godfrey H. Thomson	246
Blood Group Inheritance.—J. Ffoulkes Edwards and Dr. I. M. H. Etherington	246
Cell Size in Millipedes—H. G. Callan	247
Œstrogenic Activity of Certain Synthetic Compounds.—Prof. E. C. Dodds, M.V.O., L. Goldberg, W. Lawson and Prof. R. Robinson, F.R.S.	247
Mechanism of Propagation of Electronic Excitation Energy, and Photosynthesis in Plants.—Dr. Joseph Weiss	248
Spontaneous Isomerization of Lycopene.—L. Zechmeister and P. Tuzson	249
Research Items	251
A Simplification of Maxwell's Equations in Conformity with the Flux-cutting Principle. By Dr. C. V. Drysdale, C.B., O.B.E.	254
Food of the Herring	257
Malnutrition and Maternal Mortality	257
University Events	258
Science News a Century Ago	258
Societies and Academies	259

Editorial and Publishing Offices:
MACMILLAN & CO., LTD., ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number: Whitehall 8831 Telegraphic Address: Phusis, Lesquare, London
The annual subscription rates are: £2 12 0 British Isles, £2 17 0 Foreign, payable in advance

Advertisements should be addressed to
T. G. Scott & Son, Ltd., 63 Ludgate Hill, London, E.C.4. Telephone Number: City 4211
Registered as a Newspaper at the General Post Office
All rights reserved

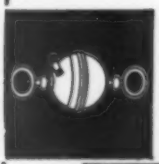
GERYK HIGH VACUUM PUMPS

ALL BRITISH

45 years ago we introduced the "Geryk"—the first practical mechanical high vacuum pump. Experience has enabled us to produce vacua, formerly unobtainable—e.g., ·01 millimetre off absolute vacua with single stage pumps, or up to ·00001 millimetre with the Duplex pattern.

2 cubic feet per minute is swept by 3-in. pump. Larger sizes up to 110 cubic feet per minute.

New pattern Geryk High Vacuum Pump



PULSOMETER ENGG. Co., LTD.
Nine Elms Ironworks, READING
39 Victoria St., LONDON, S.W.1

Write for LIST 2076

Pulsometer TRADE MARK

JUST PUBLISHED

AEROPLANE DESIGN

A Practical Treatise on Fundamental Calculations.

By E. W. C. WILKINS, B.Sc. (Hons.), A.F.R.Ae.S., M.Inst.B.E., Member of the Technical Staff of the Bristol Aeroplane Company

Written for the use of designer and student, with special reference to the use of Strain Energy Methods in stress analysis

Medium 8vo. Cloth. 318 pages. With 256 illustrations.
Price 20s. net. Post 6d., Abroad 1s.

RECENTLY PUBLISHED

AN INTRODUCTION TO THE THEORY OF STATISTICS

By G. UDNY YULE, C.B.E., M.A., F.R.S., and M. G. KENDALL, M.A.

This is the Eleventh Edition of this standard work on Statistics. The contents have been entirely revised, much of it having been re-written. All has been reset on larger page. New chapters are included on branches of the subject which are new, or have gained in importance. It is a book dealing throughout with fundamentals. Ten former editions bear eloquent witness to its value.

ELEVENTH EDITION. Medium 8vo. 570 pages.
Price 21s. net. Post 7d., Abroad 1s. 4d.

"This is the best book on the theory of statistics that was ever written."—*Nature.*

CHARLES GRIFFIN & CO., LTD.
42 DRURY LANE, LONDON, W.C.2

Bausch and Lomb

NEW MODEL "KW" WIDE FIELD BINOCULAR MICROSCOPE

with rapid changing shuttle nosepiece

An alternative to our more advanced "KW" outfit with revolving drum nosepiece.

Ideal for Laboratories, and Workshop inspection.

This model will be found optically and mechanically dependable and is **covered by our usual Guarantee.**

Write for Catalogue

BAUSCH & LOMB OPTICAL CO. LTD.
Africa House
KINGSWAY LONDON, W.C.2

INDISPENSABLE IN RESEARCH LABORATORIES

★

Admiralty
Admiralty Research Laboratories
Chemical Defence Research Station
Home Office Industrial Museum
National Physical Laboratory
H.M. Office of Works [Baird & Tatlock (London), Ltd.]
H.M. Post Office
Royal Naval College
Birmingham University (Mining Department)
British Cast Iron Research Association

are users of the

"ALNOR" VELOMETER

Where air movements are to be checked the "ALNOR" VELOMETER is an instantaneous and direct reading Air Velocity Meter of great accuracy recommended for intricate work.

"ALNOR" is the speediest instrument in the world to use. Now available with various jets for all types of air measurement.

From 20—18,000 f.p.m.

AIR CONDITIONING & ENGINEERING, LTD.,
4/12 PALMER STREET, WESTMINSTER, S.W.1.

'Phone: WHITEHALL 8291-2 *or write for free details.*

Editorial & Publishing Offices :
MACMILLAN & Co., LTD.
ST. MARTIN'S STREET
LONDON, W.C.2

Telegraphic Address :
PHUSIS, LESQUARE, LONDON

Telephone Number :
WHITEHALL 8831

Vol. 141 SATURDAY, FEBRUARY 5, 1938 No. 3562

Science in Administration

THE position and functions of the scientific or technical expert have been the subject of many discussions and much difference of opinion. The general view of administrators is that "The expert should be on tap but not on top"; but this arises from a widespread official assumption that intimate knowledge of a particular subject—unless it is of a literary or historical character—is a disqualification for an administrative post. The point of view of the professional civil servant was stated in a leading article in the November issue of *State Service*. The article suggests that a remedy of current social and economic maladjustment can only be found in the intensive use of the methods of scientific research and inquiry in problems which have hitherto generally been regarded as outside their province. If the achievements of the chemist, the physicist, the biologist and the engineer are to be correlated with the processes of public administration, and not stultified or misapplied through the inability or reluctance of politicians and administrators to appreciate the significance of new scientific development, the expert's processes of thought and action must be extended into fields of human activity where they are at present rarely encountered.

These reasons themselves have led the Institution of Professional Civil Servants to maintain insistently that, in the interests of efficient government, the heads of professional, scientific or technical branches of the Civil Service should be given an unconditional right of access to Ministers in charge of their department on all matters in which their special knowledge provides them with a particular qualification to advise. The soundness of this contention is now scarcely challenged, however practice may depart from the principle. There is, however, another point of view, which was very ably advanced by Dr. G. W. C. Kaye in his address to Section A (Mathematical and Physical Sciences) at the British Association meeting at Nottingham. Dr. Kaye challenged the dictum that qualities of leadership are more likely to be developed by the old humanitarian studies than by the natural or mechanical sciences, and ridiculed the idea that technical or scientific workers invariably require to be mothered by full-blooded non-scientific or quasi-scientific administrators.

A scientific training may be the medium for the development of latent administrative ability as much as any other career and probably more than most. Restriction of the opportunity of scientific men who possess administrative ability to advance to the highest positions of administrative responsibility, whether in the State service, in industry or elsewhere, is not only unfair to the scientific worker as a class but is also a danger to the State, by limiting the resources upon which it can draw for a type that in any event is not easy to find. The significance of this point is well illustrated in Sir Josiah Stamp's recent address on the administrator and a planned society to the Institute of Public Administration, although he nowhere referred to it explicitly.

Sir Josiah sees the problem of administration as fundamentally that of securing a greater fitness to achieve approved ends, rather than obtaining any vision of a changing task which might be more than a question of degree and involve a different type of administrator. The responsibilities of the administrator are now so wide and numerous that the question arises whether a new kind of administrative technique and ability is required, whether different aptitudes and temperaments are

logically involved, and whether the mental training should have some radical redirection.

This question of the type of administrator is all the more important in that the further question of the type of administration required in modern society has been raised in many quarters, for example, in the study of "British Experiments in Public Ownership and Control" by Mr. T. H. O'Brien, promoted by the Institute of Public Administration, or Sir Daniel Hall's discussion of possible modifications in the administration of democratic Governments to promote planning and efficiency, recently contributed to the *Nineteenth Century*. The two questions are interlocked, but we cannot be sure that we are getting the best out of the existing system unless we are using the best type of administrator in that system.

Equally, of course, it is true that an existing administrative system may be condemned as inadequate because by recruiting on too narrow a basis or through other deficits it fails to obtain or develop the best type of administrator. For this reason the recently published series of essays on "The British Civil Servant", some of which originally appeared in the *Political Quarterly*, are of special interest and significance, particularly the essay by Mr. F. A. A. Menzler on the expert in the Civil Service, and the discussions of the recruitment and training of officers in the Civil Service and the Local Government Service.

It is indeed strange that in the multitude of books on planning there is little reference to the administrative problem, and the fact that the new responsibilities involved in such corporate enterprises demand new qualities and new skills which may be the very antithesis of those required in the development of a successful one-man concern is largely ignored. As Dr. Robson suggests in reviewing a century of municipal progress, a more constructive type of administrator is required who sees possibilities and opportunities rather than difficulties and dangers, and who possesses creative ability and the capacity to promote energetic and far-reaching projects.

Under such conditions administrative ability is of greater rather than less importance, even if we are concerned with a slightly different type of administrator. Technical factors have to be assessed, but possibly technical factors in not one but half a dozen or more fields, and the administrator must consider the indirect as well as the direct effects of the proposed action or policy. The task of the administrator in the future is, in fact, as Sir Josiah Stamp points out, increasingly to secure the maximum net social product, and success of a measure or policy cannot be judged merely by sectional statistics but only by the effect on the national welfare when all repercussions have been taken into account.

This in itself clearly indicates the unsuitability for such responsibilities of the business man of the single management type, accustomed to fixing his own goal and achieving it in a competitive world, as well as the exactly trained civil servant accustomed to the analytical application of a legislative programme in a statute and working to the elaboration of a completely static programme. As a corollary it again emphasizes the importance of tapping all channels to secure an adequate supply of men of the requisite ability and vision.

If, however, it is essential that the highest administrative posts should be recruited from the widest possible field, technical and scientific as well as others, the question of training as well as of final selection remains. In this field, the idea of the staff college has only been tentatively explored, and the possibilities of vocational selection in regard to the higher posts as distinct from entrance to industry have scarcely been probed. Indeed, vocational guidance only becomes possible when the requirements for the post to be filled can be defined with some exactitude.

Obviously in this field such bodies as the National Institute of Industrial Psychology, the Institute of Industrial Administration, and the Institute of Public Administration have important contributions to make. What, however, in the first instance delays progress is the general failure, due to mis-education, to realize that scientific research and technical advance are producing strains and stresses in the structure of society which, if they do not receive prompt attention, may bring about the destruction of the social order. The status of the specialist in the Civil Service is merely symptomatic of society's general attitude towards those who are reshaping social environment.

The present unsatisfactory position has been pointed out authoritatively on repeated occasions in recent years. A report of the British Science Guild in 1931 strongly condemned the inefficiency of the practice of excluding officers of the expert class from the important administrative positions responsible for the direction of the work, and contrasted this position with the success of the opposite policy pursued in large-scale progressive

industry. The report of the Royal Commission on the Civil Service, which appeared almost simultaneously, disappointed any hopes of this position being rectified at an early date, and instead betrayed a fundamental failure to appreciate the significance of the expert in public administration. In contrast with this, the Bridgeman Committee, reporting on the Post Office in 1932, was the first public inquiry committee to give full recognition to the scientific expert in the Civil Service, and proposed in effect that he should take his place on level terms with the administrative expert and the financial expert, and have his say in the formulation of policy as in the control and execution of the routine operations.

There is thus at least one instance of public recognition of the principle that a technical man who has shown that he possesses administrative talent should be eligible for other appointments. Meanwhile progress is slow. In the Local Government Service, as has been pointed out in the P E P report and elsewhere, little or no attempt has been made to implement the recommendations of the Hadow Report of 1934 regarding the recruitment, training and promotion of local government officers, and Sir Ernest Simon is still able to direct attention to our neglect of the universities in recruiting for this service, to the absence in many of our local rulers of the scientific quantitative thinking which is the basis of wise action in social affairs, and to the need of selecting and promoting men with a single eye to the highest degree of administrative ability. Here, no less than in the Civil Service itself, is there scope for the recruitment of administrators with a wider culture that embraces a real and intimate understanding, acquired from study, of the significance of science and scientific discovery in the evolution of modern society.

The contribution of the scientific or technical expert in every sphere of life grows more and more important, and the security of society makes it imperative that his services shall be fully and wisely used. Equally the burden upon the administrator grows heavier, and we can less than ever afford to miss the rare administrator of first-class ability wherever he may be found.

Origins and Growth of Chemistry

A Short History of Chemistry

By Prof. J. R. Partington. Pp. xiv + 386. (London: Macmillan & Co., Ltd., 1937.) 7*s*. 6*d*.

THE history of chemistry, like that of Ko-Ko, "may rank with most romances", and lends itself perhaps too easily to the picturesque rather than to the accurate style of narration. As Dr. Sarton has recently observed, however, "accuracy is as fundamental in the historical field as in the scientific one, and . . . has the same meaning in both fields"; so that we may properly require an unswerving adherence to fact as the prime qualification of a historian of chemistry. The second qualification must be a first-hand acquaintance with as much as possible of the original literature and a critical familiarity with secondary authorities, while the third—of equal indispensability—is a sound knowledge of chemistry from the practical point of view. All these qualifications Prof. Partington possesses, happily backing them with a pleasant style and thus softening, without in the least obscuring, a precision of thought and an economy of words that might otherwise have appeared somewhat prim. That he has attained his expressed aim of being objective, impartial, and innocent of conventional platitudes, will be agreed by everyone who reads his present book, which affords a survey of chemistry from the earliest days to the first decades of the twentieth century.

After a preliminary chapter on ancient metallurgy, glass-making, and kindred arts, Prof. Partington deals with the origins of chemistry *qua* chemistry, adopting the generally accepted view that the birthplace of the science was Alexandria. He then describes, very briefly, the diffusion of alchemy in Arabia, India, China, and Europe. This chapter could well have been enlarged without upsetting the balance of the book, but even in its succinctness it makes clear what is not always understood, namely, that early Chinese alchemy of the centuries immediately preceding the Christian era dealt mainly with the medicine of immortality, in contrast to the transmutatory alchemy of the West, out of which chemistry arose. Incidentally, it may be remarked that Prof. Partington seems to be under some misapprehension about the "Sabeans" of Harran. The Syrian heathens of this celebrated ancient town called themselves Sabæans to avoid persecution from the Caliph Al-Ma'mun; the true Sabæans or Mandæans lived between Basra and Wasit, that is, in the region formerly known as Chaldea.

With the rise of iatrochemistry, Prof. Partington's treatment becomes fuller, and he rightly devotes several pages to the work of that accomplished chemist Johann Baptista van Helmont (1577–1644), who invented the word "gas", made extensive use of the balance in his scientific researches, expressed clearly the law of the indestructibility of matter, and emphasized that metals when dissolved in acids are not destroyed but can be recovered by suitable means. The scientific spirit was reaching adolescence, though even van Helmont believed in alchemy, and gives, indeed, one of the most circumstantial accounts of a transmutation to be found in the whole of alchemical literature.

In the late seventeenth century, and throughout the eighteenth century, the phenomena of combustion formed the focal point of chemical investigation, which had at length shaken itself free from alchemy and from subservience to medicine. Boyle (1627–1691) explained the increase in weight of metals on calcination by assuming the fixation of ponderable particles of fire, though he seems to have suspected, in certain cases at least, that the increase might possibly be due to something taken by the metal from the air. The progress made by Boyle, Hooke, Mayow and others towards a satisfactory explanation of combustion was, however, interrupted by the "false theory" of phlogiston, of which Prof. Partington gives a very clear description (though it may be argued that the adjective *false* cannot be strictly applied to a scientific hypothesis or theory—*inadequate* is less open to objection). The fall of phlogiston, through the discoveries of Priestley, Cavendish, Black and Scheele and their reinterpretation by Lavoisier, leads us on to the great days of the early nineteenth century and the foundation of modern chemistry; Dalton and Davy, Berzelius and Gay-Lussac occupy the stage, and perform Herculean deeds of intellect. The materials for the historian now become embarrassingly rich, and perhaps only those who have tried to write the chemical history of the last century and a half can fully realize the magnitude and complexity of the task.

Prof. Partington has chosen what seems to be the only method of treatment suitable for a limited space; that is, to take individual topics or individual branches of chemistry and consider them separately, showing, however, their interconnexion wherever it is possible to do so. He devotes, for example, two or three chapters to organic chemistry, one to the theory of valency, another to physical chemistry, and the final two to the periodic law and the structure of the atom respectively. His account of substitution and the unitary and type theories is remarkably lucid for such an involved subject, and the chapter on physical chemistry is equally good. But the method has its disadvantages: it is bound to occasion some lack of coherence and to give greater prominence to the trees than to the wood, while in this particular case it has led to a noticeable neglect of the progress of general inorganic chemistry—the only serious fault in an otherwise excellent book.

There are very numerous portraits and other illustrations; summaries of, and supplements to, most of the chapters; biographical sketches; a bibliography; and indexes of names and subjects. The most striking feature of the book, however, is the skill with which the author makes his reader feel the æsthetic appeal of chemistry. A chemist may be "a poet who has taken the wrong turning", but Prof. Partington will convince us that the turning was not so very wrong—and did not Wordsworth send some of his poems to Davy for criticism?

E. J. HOLMYARD.

Archæology in South Africa

Mapungubwe:
Ancient Bantu Civilization on the Limpopo. Reports on Excavations at Mapungubwe (Northern Transvaal) from February 1933 to June 1935. Edited on behalf of the Archæological Committee of the University of Pretoria by Leo Fouché. Pp. xiv+183+44 plates. (Cambridge: At the University Press, 1937.) 50*s*. net.

THE treasure-seeker has often been the enemy of real archæology. Yet sometimes, like the honeybird, he has revealed the path to those wiser and better instructed than himself. So it has been with the romantic story of Mapungubwe. Five farmers in the northern Zoutpansberg district set out to explore a lonely hill in the wildest and most desolate part of the Transvaal. To the natives it was known as the "Hill of the Jackals", and they regarded it with superstitious dread. It was sacred to the Great Ones among their ancestors. The five adventurers started to dig, and found close under the surface a skeleton with numbers of gold bangles, a bowl of gold plating, and parts of a gold-plated headrest, together with small figures of rhinoceroses in gold plating. The total weight of gold in this single find was 75 ounces.

Fortunately, two of the farmers were men of education, and the younger of these two was a graduate of the University of Pretoria. He, very wisely, reported the whole history to his former college professor, and the result eventually has been the scientific expedition of which a first preliminary record is published in this beautiful volume, splendidly illustrated with photographs, coloured plates, and a series of workmanlike plans and diagrams.

It must have been a proud moment for Mr. Van Graan when he learned that the Prime Minister, General Hertzog, had declared the exploration of Mapungubwe to be "a matter of national importance". General Smuts, then leader of the Opposition in Parliament, showed also the keenest interest. So that, in 1933, the Government bought the farm outright, and made an agreement with the University of Pretoria by which the University should undertake to excavate for five years, receiving from the Government two pounds for every pound raised by its own efforts. There was then formed the Archæological Committee of the University of Pretoria, on which the Government, the public, and the University were all represented. The City Council of Pretoria and various private citizens immediately contributed a substantial sum, with which operations were begun in June 1933.

The whole history of this undertaking and its reception by the Government and the general public is most inspiriting. It shows a degree of enlightenment as rare as it is admirable, and may stand as a great example for other and older countries. South Africa, indeed, has always been alive to the importance of its antiquities. It was Cecil Rhodes himself who saved Zimbabwe from the destroyer, and the Chartered Company soon afterwards appointed a custodian for the principal ruins in its own territory. Both Rhodesia and the Union have passed in recent years very effective laws for the preservation of their archæological heritage.

It was, perhaps, inevitable that, thirty or forty years ago, when Southern Rhodesia was still a new country, the zeal of untrained explorers should outrun their discretion. Excavations at Zimbabwe and other sites about the turn of the century and for some years afterwards were very badly conducted, and much evidence was unwittingly destroyed by those whose official duty it was to conserve it. Since 1905, however, this has been remedied, and only competent workers are allowed. Nevertheless, gold seekers, adventurers, and others had destroyed so much in Rhodesia, where the finest ruins are situated, that it is most fortunate that outlying stations of the same culture have been discovered in the bordering countries, in Portuguese territory on the east, and on the southern banks of the Limpopo in the Transvaal. These, though outwardly less spectacular, may be expected to add very greatly to the sum of evidence, and ultimately to provide the complete solution of the problem.

For it is now generally recognized that Zimbabwe is by no means unique; it is only the most striking and the most sophisticated example among a large number of stone-walled kraals belonging to a medieval and post-medieval Bantu culture. While the earliest of these may very possibly have been founded about the ninth or tenth century after Christ, the majority were at their most flourishing stages in the sixteenth and seventeenth centuries. Mapungubwe is dated to about 1500; neighbouring sites noted in this volume are later, and it is well established that the culture persisted in many places until it was destroyed by the Matabele invasions of the nineteenth century.

I have reason to remember that the opinions just expressed were very unpopular thirty years ago, though even then they were shared by many of those who knew the country and the natives best. But the work of several unprejudiced students, among whom should be especially mentioned two contributors to this volume, Mr. Schofield and the Rev. Neville Jones, has greatly changed the viewpoint of even the least scientifically minded. Miss Caton-Thompson's researches in 1929 routed the last desperate adherents of the Queen of Sheba, and it may now be considered that the "Oriental mirage" has disappeared for ever. Student and settler alike now realize that the Zimbabwe cultures represent the history of native African peoples in a period contemporary with medieval and modern history in Europe. In such a changed atmosphere we may look forward to a great development of knowledge analogous to that which has taken place in America in the last half-century. Only forty years ago the world had very slight and inaccurate knowledge of the great civilizations of the Mayas and the Aztecs. Mists of fantasy and wild speculation enwrapped them also. But now excavation and study have made the archæology of Central America a part of the established history familiar to every cultured man. There is no reason why the African Monomotapa should not be as familiar to our grandchildren as Montezuma has long been to ourselves. He is quite as authentic, and was probably quite as important.

Not only to South Africans, but also to all who are interested in a most fruitful and promising field of history and ethnography, this admirable book may be warmly recommended. It is rightly and properly technical, written with the greatest economy of words, and with little elaboration of theory, but it describes its material thoroughly and exhaustively with a completeness and precision

that leave nothing to be desired. Especially worthy of attention are the minute discussion of the pottery by Mr. Schofield, and the excursus on beads by Mr. H. C. Beck, the highest living authority on that subject. The description of the field work by the editor and by Mr. Neville Jones shows that South African excavators completely understand their problems, and are using their local knowledge as well as the experience of excavators in other fields to develop a technique suitable to the rather peculiar local conditions.

D. RANDALL-MACIVER.

The Presentation of Applied Physics

(1) Elementary Engineering Science
By Dr. Arthur Morley and Dr. Edward Hughes. Pp. xi + 290. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1937.) 3*s*. 6*d*.

(2) Engineering Science
By H. B. Brown and A. J. Bryant. Vol. 1: Mechanics and Hydrostatics. Pp. xv + 403. (London: Macmillan and Co., Ltd., 1937.) 5*s*.

(3) Further Mechanics and Hydrostatics
By A. W. Siddons, K. S. Snell and N. R. C. Dockeray. Pp. viii + 184. (London: Edward Arnold and Co., 1937.) 3*s*. 6*d*.

(4) Physics for Technical Students:
Mechanics and Heat. By Prof. W. B. Anderson. Third edition. Pp. ix + 378. (New York and London: McGraw-Hill Book Co., Inc., 1937.) 15*s*.

(5) Physics in Industry
By Karl T. Compton, E. C. Sullivan, Zay Jeffries and E. Q. Adams, Paul D. Foote, J. P. Den Hartog, John Ely Burchard, Oliver E. Buckley, Clark B. Millikan, Joseph Slepian, Homer L. Dodge, A. R. Olpin. Pp. xiv + 290. (New York: American Institute of Physics, 1937.) 1.50 dollars.

"SCIENCE increases the power of the rulers, giving them control over the sources of modern life. A wise nation, a people who intended to remain free would get to know all about science too." These words recently appeared as a random note in a daily newspaper and if there is one branch of science to which, in particular, they could be taken to refer, that branch is physics, with its many practical applications. Each of the books quoted above deals with one or more aspects of applied physics, and each, in its way, aims at promoting its study. Their perusal leaves a strong impression of the stultifying influence of the examination system — teachers, students and writers being cabined, cribbed, and confined within the limits of the syllabus chosen.

(1) In the first example, the National Certificate code provides the limitation, by which term is to be understood such restriction of view as is ensured, in a physical sense, by the blinkers in the harness of a horse so that he may see no more than lies directly ahead. The book provides a course of instruction in engineering science for students in the first year of their preparation for the Ordinary Certificate in Mechanical or Electrical Engineering and, as such, it is a very good course consisting mainly of elementary mechanics with a modicum of heat and electric technology.

The basis of the treatment is the principle of work, which certainly provides an easy approach, but the book suffers from the effects of compression, as, for example, in the condensing of a phrase until it lacks precision. To the teacher, it will certainly be useful as the foundation of a session's work.

(2) Messrs. Brown and Bryant's book on "Mechanics and Hydrostatics" is somewhat more advanced and includes two years' work for the Ordinary National Certificate and sufficient preparation for preliminary professional and entrance examinations. The authors have adopted an easier style and have freely used such elementary mathematics as is necessary for the adequate presentation and solution of problems. The treatment is based on a scheme of experimental work, which is fully outlined, and throughout the book reference is made to practical examples.

The clarity of the argument and the excellence of the diagrams make it likely to prove a helpful text-book in the early stages. The later chapters on strength and testing of materials, hydraulic machinery and the mechanics of fluids provide excellent preparation for the higher stages.

(3) It is for a different class of student that Messrs. Siddons, Snell and Dockeray have prepared the series entitled "Mechanics", of which the present volume constitutes the third part. It meets the needs of those who are in the early stages of their preparation for the Mechanical Science Tripos at Cambridge or for higher mathematics in the Army Entrance Examinations. Here a much more academic treatment of the subject is adopted, and readers require a sound knowledge of mathematics including some calculus. The formal method of presentation will be found very suitable for those students who have had a well organized and directed education and have been trained to study methodically.

(4) While each of the three preceding books is good in its way and within its limitations—which are those of examination syllabuses—and may be accepted as a reliable medium of instruction, they lack enthusiasm. They work methodically and conscientiously through the allotted task, but will not evoke in the student a wider interest in the subject. In sharp contrast, Prof. Anderson takes up his subject with an obvious sense of its importance and of its absorbing interest. While writing for students of science, agriculture, engineering and other branches of applied physics, he urges its cultural value to all. This is not to suggest that his treatment departs from the logical and recognized course, but rather to indicate the spirit in which the instruction is given and the easy introduction of practical topics to illustrate and reinforce it. For example, after dealing with fluids in motion and reduction of pressure with increase of velocity, he leads up to a discussion on carburettors, ship collisions, pitot tubes, the rotor ship, venturi meters, steam injectors, organ pipes and several other examples. With such a book the student will gain greatly in his mental outlook.

(5) The last of these volumes is in a different category. It contains a symposium of essays on the applications of physics in industry by different American authorities in the glass, metal, oil and other industries. Though by no means equal in quality, they all, with perhaps one exception, reach a high standard of interest and of technical value. It is a book which should be read not only by every scientific worker and engineer but also very widely by the general public, to whom it would convey the vast importance of physical science in modern life.

Analysis of Animal Foods

The Structure and Composition of Foods

By Dr. Andrew L. Winton and Dr. Kate Barber Winton. Vol. 3: Milk (including Human), Butter, Cheese, Ice Cream, Eggs, Meat, Meat Extracts, Gelatin, Animal Fats, Poultry, Fish, Shellfish. Pp. xxv + 524. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1937.) 40*s*. net.

WHEN the two preceding volumes of "Winton and Winton" were issued, we believed, as did the authors, that the third volume would complete their work. Apparently, however, they had under-estimated the range of products needing survey, and they have now had once more to postpone the end of their labours. The publishers state that volume 4, in preparation, will cover the remaining foodstuffs—sugar, syrup, tea, coffee, cocoa, spices, extracts, etc. Volume 3, however, will be for many the climax of this important and useful work, for the analysis and control of animal foods offer, broadly speaking, greater difficulties to the technologist than do even some of the knottier problems in the control of cereals and seed oils.

Books of this type must always suffer from one inherent disadvantage. In this volume, for example, it must have been very difficult to decide exactly how much space to allot to milk and milk products; actually they receive 209 pages. Eggs (in Part 2) occupy a further 50, miscellaneous animal products some 30, meat and meat products just under 140, fish and fish products a further 50. The remaining pages are devoted to batrachians and reptiles and to an index.

It is clear that 200 pages about milk and milk products constitute, in effect, a monograph on the composition and analysis of dairy products—matters that have been very adequately treated in a number of specialized books. Is there really any call for its treatment at such length here? If, on the other hand, it had been decided that much shorter treatment would be satisfactory, the authors would immediately have laid themselves open to the charge of inadequacy.

We must admit that this is a problem that we are glad not to need to face. The authors, however, have had to face it and, granted the premises that decided their editorial policy, have done so with considerable success. It is, of course, impossible to check anything but random samples of the facts summarized in such a book. References appear to be brought up to 1936, and include such recent information as the Levene formulæ for yeast nucleic acid and thymus nucleic acid, and for inosinic acid.

The book is unfortunately not free from gross printer's errors. For example, "Greatine" on page 275. Also, much of the information collected by the authors about the effect of cooking on meat (and other foods) has now been rendered obsolete by the studies of McCance and Widdowson. Nevertheless, the book will remain permanently useful, not only as a record of facts, but also as a record of the kind of facts that have been recorded.

A. L. B.

The Conquest of the Stratosphere
By Chas. G. Philp. Pp. ix + 205. (London: Sir Isaac Pitman and Sons, Ltd., 1937.) 7*s*. 6*d*. net.

MR. PHILP'S two books are of very different value; their defects are alike, their merits dissimilar. Both are marred by a superficial and far from accurate handling of scientific facts and hypotheses, and both suffer from that adjectival rash which infests so many works of popular science—"hazardous risks", "intrepid explorers", "unknown regions", "entrancing story", "astounding information", "tremendous height" and so on. As for "evaporizing", "stratonaut", "astronautist"—what words!

The merits of "Stratosphere and Rocket Flight", which was published some time ago, lie in its exaggerations, its failure to present a fairly balanced picture of the great practical difficulties that must be overcome before the great theoretical possibilities of reaction propulsion are converted into directed achievement. They are merits, because they are sufficiently obvious to a reader of the most modest intelligence, and because they will compel the reader to think and question at every page. "The Conquest of the Stratosphere" opens inauspiciously with a chapter in which our incomplete knowledge of the atmosphere is presented in obsolete and misleading form. Scientific facts and the scientific results of stratospheric flight are not presented in a form which will convince the average reader that justification of the pains is yet in sight.

But a clear majority of the pages are devoted to vivid and straightforward description of each of the historic manned balloon flights into the stratosphere, from Glaisher and Coxwell in 1862 to Stevens and Anderson in 1935. The stories, which are mainly based on a close (sometimes too close) following of the actual logs, are absorbingly interesting, and the modest price of the book is handsomely earned in this connected narrative of exploration. It can be most cordially commended to everyone who needs reassurance that grandeur can still in the twentieth century be attained in communal organization and in individual courage, freed from passion and self-interest. For those not yet tormented by philosophic doubts and fears, it is a fine story book.

Insects of the British Woodlands
By Dr. R. Neil Chrystal. Pp. xiii + 338 + 33 plates. (London and New York: Frederick Warne and Co., Ltd., 1937.) 7*s*. 6*d*. net.

THIS book is intended primarily for those who are concerned with the management of British forests and woodlands. Through the operation of the Forestry Commission, extensive tracts of land have been taken over in Britain for planting with forest trees. These trees include both native and alien species and, as the work goes forward, increasing attention will be directed to their various insect enemies. There has been a very evident need for a good practical manual on the insect enemies of the forester and, in fact, of trees in general. Such a work requires to be up to date and treat of the insect concerned in close connexion with methods of forestry practice.

This want may be regarded as being adequately met by the present book. Those who use it will find sufficient introductory matter to become acquainted with the essential features of insect biology and structure. They will also be able to name, without undue difficulty, the more important insects encountered and, at the same time, gain an insight into their habits and relation to forestry. The various conditions and circumstances which govern insect outbreaks in woodlands are explained: both natural enemies and artificial methods of repression are clearly discussed, while simple methods for the collection and study of insects are given.

Written by an author who has had much first-hand experience with the subject, the book provides the sort of information that is required. It is not overburdened with technicalities, and the clear, straightforward style in which it is written should commend it also to the notice of nature study teachers and others interested in insect life. It is well and fully illustrated and very reasonably priced.

A. D. I.

Sound-Recording for Films:
a Review of Modern Methods. By W. F. Elliott. Pp. xi + 134 + 12 plates. (London: Sir Isaac Pitman and Sons, Ltd., 1937.) 10*s*. 6*d*. net.

THE accuracy of aim, clarity of conception, and exactness of expression which characterize Mr. Elliott's work are well illustrated in its title. His book is not one on "Sound Recording on Film", with detailed description of the physics and chemistry of the sound track and the related apparatus. It is a shrewd and stimulating discussion of the art of that highly skilled, imaginative, ingenious, agile and patient collaborator in film-making who bears the regrettable though comprehensible title of "recordist". A very few inexactitudes and obscurities in the brief references to acoustic physics are quite unimportant in a book full of wisdom, common sense and sound artistic judgment.

Although it is designed as a practical guide to the technician, the book is of a much wider interest. Its claim to be the first of its kind is justified, and it should be read not only by every recordist but also by every director. The general reader will find it enthralling and illuminating. He will get a fair impression of one aspect of that almost incredibly onerous labour, that meticulous care, and that more than humanly patient iteration which goes to the making of a good film, and of which direct evidence must be completely absent from the good film.

Nearly everything that Mr. Elliott says is so right that there is a temptation to call it obvious. A visit to an average film show will cure the temptation, and will renew the feeling that such a visit must be a somewhat painful experience for Mr. Elliott and for any recordist of his high quality and ideals.

A word must be said for the ingenious "post-synchronization" of the dust-cover, which shows on the front a typical film scene and on the back the battery of technical aids which stands—in this case literally—behind the scene.

Iodine*

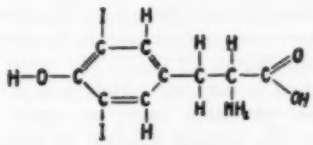
By Prof. Irvine Masson

OF the two aspects of iodine and its chemistry which are here surveyed, the first is that of the part played by the element in terrestrial economy, whether inorganic or organic or both. In the total make-up of the earth, iodine is not one of the fourteen elements which compose 99·95 per cent of the mass, but is one of the rarest of the non-metallic elements. Nevertheless, it is scattered almost everywhere, in minute traces; a ton of average rock contains some 300 milligrams, a ton of sea water about 17 milligrams.

The chemical reactions of geology have very rarely segregated any of these widely dispersed traces; there are scarcely any minerals containing iodine as an essential constituent, and the few that have been found are out-of-the-way mineralogical curiosities, small specimens rather than deposits or ores. Only in one place in the world have solid iodine compounds come together in quantity, and that is in the nitrate deposits of Chile, high up against the western slopes of the Andes. There the element occurs as inorganic iodate, and there are uncounted thousands of tons of it. Yet, even so, the iodate is not by itself in veins or beds, but is simply one of the minor impurities in the great accumulations of sodium nitrate. We might be able to explain how the iodate got there if we knew how the nitrate had got there; but, in spite of much interesting work, all that seems really safe to say about the origin of Chile nitrate is that no single hypothesis has yet met all the known facts. What is indubitably true is that the world's commercial supply of iodine (with trifling exceptions) comes from the Chile nitrate factories, from which it is exported at the rate of nearly 1,000 tons of the element yearly.

It seems from these facts that during the 2,000 million years which span geochemistry, iodine has played a part that was practically nothing, and that had the element never been created, the inorganic earth would not be appreciably different from what it is. But with the origination of organic life (800 million years ago, or earlier), iodine began to matter. First it became not wholly dispersed, but partly to be segregated from solution in the sea into the colloids of living organisms floating there. Then, as the forms of living things developed, the iodine was not only taken up into them, but also became a chemical part of some of them. They developed still further and more variously; and now, the vertebrates, and we ourselves, could not continue without iodine, either as individuals from month to month or as species from generation to generation.

Looking more closely into this from a biochemical point of view, we learn from many recorded analyses of vegetable and animal materials that three living creatures stand out far beyond the rest as being rich in iodine. These three are seaweeds (brown and red), bath sponges, and certain classes of corals. One of these is vegetable, two are animal, but all three are marine; and this is so notwithstanding the fact that the sea water is excessively poor in iodine compared, for example, with many soils and most rocks. The iodine content of these organisms is thousands or even millions of times more than in the sea water in which they live; it may reach one half per cent of the weight of the dry tissue in seaweed, one per cent or more in the sponges, and in a coral as much as eight per cent. The chemical form of this iodine is undecided in the case of seaweed; but as to the horny sponges and horny corals, the work of Drechsel (1896) and of Wheeler and his associates (1905–7), confirmed by that of Mörner (1907–13), showed, surprisingly, that the skeletal protein releases its iodine as the definite aromatic amino-acid, 3 : 5 di-iodo-tyrosine:



3 : 5 DI-IODO-TYROSINE

It is improbable that this substance is supplied to the animal cells ready-made in their plant food; such food no doubt brings them the common protein ingredient, tyrosine, but the iodination would seem to go on in the cell. For this purpose, the very minute traces of dissolved inorganic iodine salts in sea water are drawn upon; and if these are iodides, the co-operation of an oxidizing agent is obviously necessary (an oxidase naturally suggests itself). The direct iodination of tyrosine in the laboratory, with elementary iodine as the

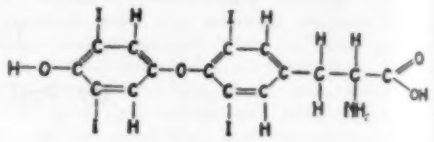
* Substance of a Friday evening discourse at the Royal Institution, delivered on December 3, 1937.

reagent, was easily accomplished by Oswald (1909) and has lately been studied in more detail, as a part of protein chemistry, by Bauer and Strauss (1935).

It is particularly to be noted that organic halogen compounds of any kind are extraordinarily rare among natural products. The only other cases known at present are: di-bromo-tyrosine, obtained by Mörner (1913) from horny corals, and evidently formed in the same way as the di-iodo-compound; di-bromo-indigo, the classical Tyrian purple dye from the glands of the shellfish *Murex* or *Purpura* (Friedlander, 1909, 1922); certain aromatic chloro-compounds lately isolated from lichens (Nolan, 1934; Pfau, 1934); and other chloro-compounds which, as Raistrick has shown (1936), are formed by certain moulds growing in solutions of inorganic chloride.

No experiments seem to have been made in order to learn whether the addition of iodine compounds to sea water, or their removal, affects the growth of those marine organisms in which iodine is found organically combined. It is worth noticing, however, that the iodine compound is accumulated not in the fleshy cell-tissue of the sponge or the coral, but in the horny skeleton on which these living cells sit; and this skeleton, though mechanically useful to the cell colony, may almost be called an excretory product of that colony. It is for the animal physiologist to decide whether in these cases the skeletal protein is serving as a mere dump for di-iodo-tyrosine that has been discarded by the cells as useless, or whether, on the contrary, it acts as a reserve store upon which the cells can draw for part of some vital process. This question, unsettled though it is, is not without significance in the light of the biochemistry of animals higher up in the evolutionary scale.

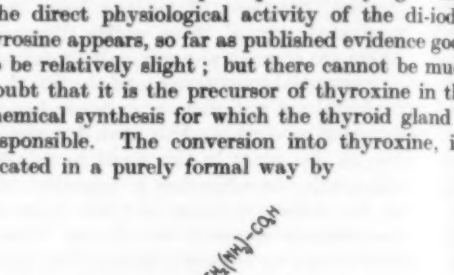
Sponges and corals are lowly creatures, with small differentiation of tissues and no co-ordination of parts, and they existed even in Cambrian times, long before forms of land life were evolved. Making, then, a very wide biological jump to the vertebrates, including man, we again find the faculty for the organic fixation of iodine, and it is localized now in the thyroid gland. That it here determines the metamorphosis of amphibian larvæ, such as tadpoles and axolotls, was first shown in 1912; and the well-established correlation of inadequate traces of iodine in food with irregularity in the function of the gland, and consequently with the disturbances of basal metabolism which cause goitre, imperfect growth, myxœdema, or cretinism, was given a rational basis first by Kendall's isolation (1915) of the thyroid hormone as a crystalline organic iodine compound which he called thyroxine, and then by the brilliant work of C. R. Harington and his associates (1926 *et seq.*), to whom we owe our knowledge of what thyroxine really is.



THYROXINE

It appears that the iodine atoms in this molecule are essential to the physiological potency of the substance; and a teleologist might well find in this hormone molecule the sole *raison d'être* of the element iodine.

Harington has shown that thyroid iodine is present partly as thyroxine but also as di-iodo-tyrosine, both amino-acids being chemical components of the complex protein thyroglobulin. The direct physiological activity of the di-iodo-tyrosine appears, so far as published evidence goes, to be relatively slight; but there cannot be much doubt that it is the precursor of thyroxine in the chemical synthesis for which the thyroid gland is responsible. The conversion into thyroxine, indicated in a purely formal way by



has not been accomplished in the laboratory (the pioneering synthesis of thyroxine by Harington and Barger necessarily used materials and methods not natural to living tissues), but it would involve steps of a kind not unknown in other branches of protein chemistry.

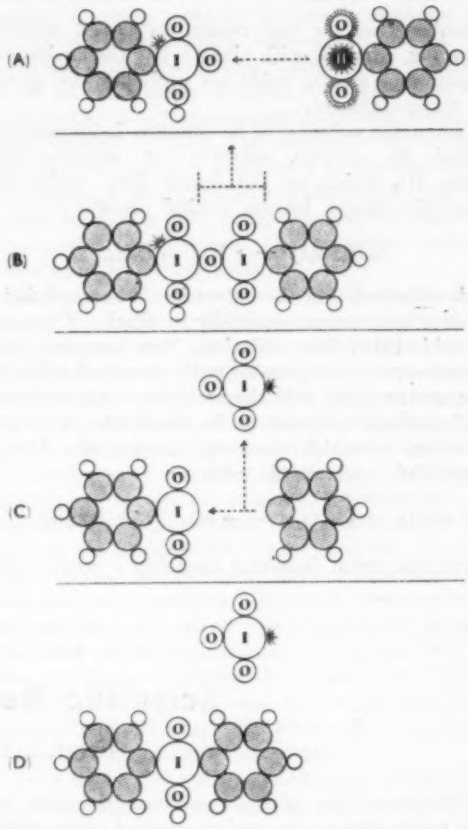
To sum up this part of our subject: the opportunity for the natural fixation of inorganic iodine into an organic form has in all ages been extremely slight; not because the process is intrinsically difficult (for it is not), but because the supply of inorganic iodine has always been extremely scanty. Accordingly, iodine is not one of those elements which, like sulphur or phosphorus, became normal ingredients of common proteins. Living things had next to no iodine to draw upon, so most of

them managed and evolved without it. But very early in the history of multicellular animals in the sea—if we may make an inference from those simple forms which have survived into this age—the organic fixation and accumulation of iodine was accomplished by some of them, and what they did with it was to make it into di-iodo-tyrosine. This same faculty of making di-iodo-tyrosine, we find, has been preserved, or at any rate repeated, by the vertebrate animals, localized in their thyroid glands. Besides that faculty, we have put our finger upon one further chemical step, which has apparently accompanied the evolution of the vertebrates, is characteristic of them, and is indispensable to their being: namely, the final conversion of di-iodo-tyrosine into thyroxine.

That iodine is a biochemical element is a fact which lends importance to its organic chemistry in general; and in what follows, one part of this will be discussed, namely, that in which organic iodine is multivalent. In this field, some is not new but is perhaps undeveloped, while the rest is new; and to illustrate it, we shall confine ourselves here to a few connected examples drawn from work done at Durham (*J. Chem. Soc.*, 1669; 1935. 1718; 1937. NATURE, **139**, 150; 1937). Throughout, the chemist has to bear in mind that iodine is not merely the heaviest halogen, but—especially when multivalent—is also the terminal member of its series in the Periodic System, and its behaviour is to be regarded accordingly.

Victor Meyer and Wachter's discovery of iodosobenzoic acid (1892) prompted Willgerodt to study iodobenzene dichloride, which he had isolated seven years before, and so to discover iodosobenzene and, ultimately, many other aromatic iodoso-compounds. Besides behaving as bases towards acids, these derivatives of tervalent iodine exhibit self-oxidation-reduction, as do nearly all inorganic compounds in which a halogen atom is in an intermediate state of valency; so iodosobenzene spontaneously turns into iodo- and iodoxybenzene, which latter compound has reactions of general chemical interest.

Iodoxybenzene, $C_6H_5IO_2$, is not only formally analogous to nitrobenzene, $C_6H_5NO_2$, but also by its chemical behaviour shows the internal electrical polarity which is known, on a variety of evidence, to exist in nitrobenzene. The respective donor atoms iodine and nitrogen are positive, the acceptor oxygen atoms are negative. Hence an iodoxy-compound is attacked either by negatively charged ions or parts of other molecules, which its positive iodine attracts, or else by positively charged ions or groups, which its negative oxygen atoms attract. In nitrobenzene, the small donor nitrogen atom is screened by the phenyl and by the two oxygen atoms, and is therefore not exposed to negatively charged reagents as is the large iodine; but its negative oxygen atoms are open. Thus, both compounds form salts with



Drawings of four successive stages of a model showing the expulsion of the iodate ion. The diagram illustrates the general nature of the other models also. The backgrounds were black. Positive ions were marked by the emission of a bright red light from the group of atoms; negative ions by that of a bright blue light (indicated by a small conventional 'explosion' sign). Polarities within molecules were shown by a red glow over the disk of a positive (donor) atom and a blue glow over the disk of a negative (acceptor) atom, as suggested in the drawing of the molecule of iodoxybenzene on the right in the first stage.

strong acids, by the co-ordinating (with resonance) of a proton with their oxygen atoms; for example, the crystalline hydrogen-sulphates:

$[C_6H_5IO_2{\cdot}H]+[HSO_4]-$	$[C_6H_5NO_2{\cdot}H]+[HSO_4]-$
Iodoxybenzene hydrogen sulphate. (Cryst., mp. 127°)	Nitrobenzene hydrogen sulphate. (Cryst., mp. 12°)

Iodoxybenzene dissolves in alkali, owing to the attachment of a negative hydroxyl ion to the

positive iodine, yielding the unstable solute, the *phenyl-iodoxylate* of the alkali metal:

$$\underset{\text{Iodoxybenzene}}{C_6H_5IO_2} + \underset{\text{Sodium hydroxide}}{Na^+(OH)^-} \longrightarrow \underset{\text{Sodium phenyl-iodoxylate}}{Na^+[C_6H_5IO_2H]^-}$$

Nitrobenzene, for the reason explained above, does not combine with alkali; but the arylphosphonic and arsonic acids are probably analogous to the iodoxylates.

When the solution of an alkaline iodoxylate is boiled, its complex negative ion extrudes the group IO_2, which, as the iodate ion, carries off the ionic charge, leaving behind benzene:

$$C_6H_5IO_2H' \longrightarrow IO_3' + C_6H_6.$$

This elimination of the iodate ion is characteristic of such substances, especially in alkali. Thus, in a cold iodoxylate solution, the complex ion spontaneously co-operates with dissolved iodoxybenzene to do so, and the residues couple to form *diphenyliodyl hydroxide* (or its alkali salt), with the structure of which one may compare the diaryl phosphinic and arsinic acids:

$$PhIO_2 + PhIO_2H' \longrightarrow IO_3' + Ph_2IO.OH.$$

Again, the same dominant tendency is seen in the formation of iodonium compounds by Victor Meyer and Hartmann's second method, where iodoso- and iodoxy-compound react together in an alkaline medium:

$$RIO_2 + RIO \longrightarrow IO_3' + R_2I^+.$$

The converse of these processes, that is, the return of iodine from inorganic iodate into the organically combined state, proves easy to realize in the laboratory, under conditions of high acidity, organic derivatives of multivalent iodine being formed.

It will be understood that in these examples of reactions (all of which, in the discourse of which this is a condensation, were illustrated by working scale-models showing the atomic and electrical exchanges), the detailed intermediate mechanisms have here been slightly simplified, especially as regards the organic parts of the groups concerned. In them, however, the primary point is rather the formation and existence of hitherto unknown types of iodine compounds. These lead to a new field of chemical inquiry, and help to show, as do the biochemical facts reviewed, that we must think of iodine as an element which, like nitrogen or arsenic, is not inorganic alone, but is emphatically an organic element also.

Scientific Research in India

From a Correspondent

THE activities of the scientific delegation in India were by no means confined to the proceedings of the Congress in Calcutta and to sight-seeing. Every opportunity was taken by individual members or groups of members to inform themselves of the progress of science in the various institutions which occasion could be made to visit. The notes which follow cannot be exhaustive, as they are based upon information only from members of the party who have just returned to England in the S.S. *Strathaird*; a substantial number of the delegates are not yet home.

The discovery of the pre-Aryan civilization of the Indus basin has stimulated studies in Indian archæology, and the delegation was profoundly impressed by the care bestowed upon the famous frescoes and sculptures in the rock-hewn temples at Ajanta and Ellora, while excavation is in progress elsewhere in the dominions of H.E.H. the Nizam of Hyderabad. The museums at Delhi, Bombay, Sarnath (near Benares), Calcutta and Madras all possess notable treasures, and that at Calcutta especially needs much greater space for its adequate exposition in order to guide future excavation. Turning to work within the scope of present-day anthropology, the Brahmachariya Sangha founded by the late Maharajah of Kazimbazar illustrates a type of Indian organization designed to help especially aboriginal peoples to overcome handicaps due to lack of knowledge of Hindu or Dravidian languages and to general backwardness. The aborigines around Ranchi on the Chota Nagpur plateau are being taught on the basis of a modernist interpretation of the Vedas, and schools, clinics and legal aid come within the province of this organization.

Elsewhere, the great medical institutions naturally attracted attention. At the famous Haffkine Institute in Bombay special note was taken of the work in progress towards a theory as to outbreaks of plague after periods of immunity; it was learned incidentally that mice are found more suitable than rats for plague experimentation. The work on rabies was also remarked; and it was

observed that in Bombay malaria has been reduced to almost negligible proportions by covering in all open water tanks with fine-meshed wire netting or with glass. The School of Tropical Diseases at Calcutta is worked in connexion with the hospital, where there are beds for keeping cases under prolonged study and treatment. The All India Institute of Hygiene and Public Health possesses fine premises, but there appears as yet to be a shortage of expert workers; and it may be remarked here that a more extensive supply of current medical and scientific journals, English and foreign, is apparently needed in medical libraries. It was satisfactory to note the increasing number of women's hospitals, staffed by women, especially in such a land as India, where so many women are debarred from medical aid unless rendered by their own sex. Women doctors are increasing in number, but an adequate supply of good nurses is as yet far from assured. Medical psychology was found to be fairly well established in Calcutta, and an excellent general and educational psychology is rapidly gathering strength in Mysore. The value of industrial psychology is well recognized; the material aspects of the science appear to outweigh the purely philosophical.

Research in agriculture, obviously of outstanding importance for India, aroused much interest. For example, at the Imperial Agricultural Research Institute in New Delhi, the results were exhibited of crossing the sugar-cane with a species of bamboo which grows to a height of 60 feet, and also with sorghum and Indian corn. This work forms a part of breeding experiments carried out in order to discover the origin of cultivated sugar-canes and to improve them by hybridization. In the chemical department of the Institute valuable work is in progress on the utilization of atmospheric nitrogen in soils. The visit to Dehra Dun gave the delegates opportunity to see something of the important work of the Forest Research Institute, in which departments are concerned not only with the problems of forestry itself but also with timber testing and preservation and the uses of wood-pulp, resins and other products. The Punjab Agricultural College and Research Institute afforded an opportunity for observing the progress of valuable economic research in various departments, which has already added much to the agricultural wealth of the province. At the University of Agra the dissemination of cereal rust fungi has been under investigation for seven years, and the foci of infection have been traced to hill-tracts where rusts remain during summer in the uredo-stage. The good work of the cotton research and textile research laboratories is well known, and in consequence the opportunity of seeing some of the results at Bombay was welcomed. Plant virus work on tobacco leaf curl and on mosaic of sugar-cane was found to be in progress at more than one centre, but none was encountered on potato virus diseases, though preparations are being made at New Delhi for a general assault on these problems by genetic methods. In connexion with animal husbandry, one of the delegates comments in the highest terms upon the work of the Indian veterinary colleges and the cattle and other breeding establishments which he was enabled to visit. In the notes of another delegate reference is made to a secondary school at Bikram, a village south of Patna, which possesses a demonstration farm partly worked by pupils in the agricultural class; the principle appears capable of wider application.

Delegates were fortunate in being able to take part in the hundred and fiftieth anniversary of the foundation of the Calcutta Botanic Gardens, which have been directed by so distinguished a succession of botanists and have played so important a part in the development of systematic botany. The small aquarium at Madras, the extension of which is contemplated, was much admired for the interest of some of its special exhibits, for example, the sea-snakes. Some adverse comment was directed against the attendants, whose artificial stimulation of the exhibits for the entertainment of visitors was deprecated. The zoological garden at Mysore was particularly noteworthy for the care bestowed on its lay-out and upkeep and for the fine and happy condition of the inmates. It was noticed that the enclosure of the giraffes by a small ditch and a single rail about eight feet above ground seemed entirely adequate.

It is well known that the Geodetic Survey has its headquarters for mapping and fieldwork at Dehra Dun; but reference is due here to the latitude variation station at Agra which, it is hoped, will prove to be more free from causes of systematic errors than the station previously at Dehra Dun, which suffered from poor conditions for observation owing to its nearness to the Himalayas.

It is not the object of this report to comment further upon the work of the research departments and institutions so long associated with the Governments of India; nor can it be attempted to review all, or even any large fraction, of the work of the various universities visited by the delegation. But special reference has been made by one of the delegates to the important applications of science to industry under investigation in the chemical laboratory at the University of Lahore, which are directed primarily to the utilization of waste products. Thus, cottons are improved in appearance by treatment with colloidal solutions of certain silk-like cotton wastes,

resins are recovered from oil residues, soaps are made stable in colour and perfume, waste molasses is made into tiles and insulating materials, broken rice grains of little or no value are changed into colloidal solutions and used for making synthetic rice grains, oils are purified so as to burn without smoking. Researches of a fundamental character are being made into the magnetic properties of atoms and molecules with the object of revealing the nature of chemical bonds and the control of chemical reactions. At the Tata Institute at Bangalore the experiments in the physics section on backward internal scattering of light in liquids and the effect of supersonic waves on refraction show a combination of high experimental skill and first-class apparatus. A demonstration of the structure of lustrous shells was beautiful and impressive.

Among other notes, one of the delegates was struck with the initiative shown in making apparatus, which otherwise would have been hard to come by in India, at the Central Meteorological Station for altitude observations in Agra. Another comments upon the fine work of the Hydrodynamic Research Station at Poona, where, beneath the great irrigation dam, large-scale experiments are possible and have resulted in numerous and various records covering the work of years and published by the Government of India, but yet to be incorporated, as they should be, in text-books on hydraulics.

Such are a few examples—and it must be emphasized that they are only a few among many—of the widespread and practical interest in the advancement of science and its applications encountered by the delegation in India. If the delegation, through the contacts which its members have made, has succeeded on one hand in aiding that advancement in any manner, and should succeed, on the other hand, in broadening understanding at home of the achievements of scientific workers in India, it will have discharged its most important functions for the benefit of science in both countries.

The Aurora of January 25-26

THE auroral display on the night of January 25–26 was remarkable not only for its brilliance but also for the wide area over which it was observed. Some time must elapse before it is possible to collect complete information, but it seems certain, from the newspaper reports already published, that it was seen over practically the whole of Europe, and as far south as Gibraltar and Sicily. *The Times* of January 27 states also that vivid auroral displays were seen over a large part of Canada on the nights of January 24–25 and 25–26.

Accounts of the phenomenon as observed in the British Isles differ considerably in points of detail. It is proposed to give here a few extracts from the most precise reports received either by NATURE or by the Meteorological Office. An account of the appearances observed at Harpenden, Herts, by Dr. B. A. Keen was given in last week's issue. Dr. Keen observed the display from 6.45 until after midnight. Three periods of brilliant display were noted, around 7.45, 8.30 and 9.45. The main features noted were red glows in the north-west and north-east, with a low green arc between during the early stages, green and white rays traversing a bright red glow in the north-north-east about 7.45, and rapidly fluctuating green streamers between north-west and north-east about 9.45.

At Kew Observatory, detailed observations were made between 6.50 and 9.10. These observations show good general agreement with those made by Dr. Keen, except that a green coloration of the arcs and rays is not mentioned. Strong groups of coloured rays were observed after 7.35, and at 7.51 these were spreading out from north-north-east to west-north-west reaching elevations of 5° to 10° above Polaris. At 7.57 the glow extended slightly beyond the zenith. A few minutes later, at 8.07, the display faded completely and no aurora was visible for several minutes. The later stages as observed at Kew were distinctly less brilliant, though there were some further appearances of arcs, patches and rays.

Mr. Charles Leaf sends details of observations made near Cambridge from 1.15 on January 26. He writes as follows :

"As seen at 1.15 G.M.T. there was a bright greenish glow behind banded cirrus cloud right across the northern horizon, while just to the north-west of the zenith there were two parallel bands of delicate pinkish light. Short groups of rays frequently developed in these bands. The rays were paler than the bands themselves, and gave the impression that they were white rays showing through the bands. The pink coloration gradually spread across the zenith towards the south-east where it appeared as a darker red patch, due to the background not being illuminated. At the same time there appeared a few faint luminous marks to the north-east, again quite close to the zenith. By 1.35 all that remained was a much fainter glow to the north and north-west, and this persisted until 2.30, when I went to bed."

A letter received in the Meteorological Office

from Mr. J. M. Brierley, of Rodwell, South Petherton, Somerset, describes the phenomena as seen on a motor-car journey from Honiton to Ilminster. Here a rosy glow was observed in the north-north-west as early as 6.0 o'clock. By 6.30 the glow had increased greatly in size and brilliance, and numerous pale green streamers were observed. Until 8.05 the main features were a general display of rose-coloured light above a greenish arch extending almost from west to east, and reaching almost to the zenith. A period of maximum brilliance occurred at 8.05; the greenish arch was then at an elevation of about 45°, and above this was a rose-coloured arch nearly 90° broad. Numerous bright streamers appeared along the whole greenish arch and converged to a point between Aldeboran and the Pleiades. The green arch persisted until 11 p.m., after which the display was terminated by cloud.

Mr. R. Moss, Wellington College, Berks, has sent us a copy of a detailed record of observations made by two pupils, M. Majendie and J. H. Gordon, at the College, between 6 p.m. and 11.30 p.m. The period of maximum activity and brilliance was noted to have occurred between 7.45 and 8.0 o'clock and a second very active period between 8.30 and 8.45. Observations of the characters and extensions of different parts of the display were made every few minutes, and notes were written down at once, so that the record has far greater value than the general accounts of the display usually regarded as sufficient. A copy of the notes has been sent to the auroral branch of the British Astronomical Association, and Mr. Moss will be pleased to supply further information concerning the observations to anyone especially interested in them.

In a leading article in *The Times* of January 27, reference was made to the belief, going back to the time of Tacitus, that the aurora gives forth sounds. It is of interest to record that an observer at Catcott, Bridgwater, Somerset, the Rev. Harold Buckton, states that he seemed to hear now and again faint clicks resembling the noises made by the sparking of an electric machine. He is positive that these sounds were not caused extraneously, and he was not in fact aware of the possibility of sounds in association with the aurora, until he saw the matter referred to in *The Times*. The modern view is that sound could not reach the earth's surface from an electrical discharge occurring at heights of sixty miles or more, but we include the observation in these notes for what it is worth.

The subject was referred to by Prof. A. S. Eve in a discourse delivered at the Royal Institution on February 7, 1936, and published in a supplement of NATURE of May 16, 1936. Prof. Eve's view is that the aurora can make little or no noise, and that what is heard is of the nature of local brush discharge such as is frequently associated with electrical disturbances. An interesting letter upon the subject appeared in our issue of December 2, 1933, from F. T. Davies and B. W. Currie, of the Canadian Meteorological Office, Toronto.

SOLAR AND TERRESTRIAL RELATIONSHIPS

The great aurora and magnetic storm of January 25 last was a spectacular reminder of a solar-terrestrial relationship, the evidence for which has been slowly accumulated for nearly a hundred years. Although the connexion between magnetic storms and the aurora borealis (or australis) is not a simple one, yet there is in general a close association between the two phenomena. The observation of disturbances in the earth's magnetic field is a fairly straightforward matter, requiring, of course, a specially prepared magnetic observatory, but being independent of the weather. On the other hand, data of the aurora are disturbed by cloudy weather and the periodic occurrence of bright moonlight. As defined at Greenwich, a small magnetic storm is a disturbance in which the range in magnetic declination equals or exceeds $\frac{1}{2}°$ or that in horizontal force or vertical force equals or exceeds 150 γ; a great storm is one having double these ranges as minimum (see NATURE of January 29, p. 192).

The evidence for a solar connexion with magnetic storms and associated auroras may be briefly summarized as follows: (1) a general accordance between the frequency curves of sunspots (or some other suitable criterion of solar activity) in the well-known eleven-year cycle and similar curves of magnetic storms. (2) An observed tendency for the lesser magnetic storms to recur at intervals of about twenty-seven days, which is the time taken for the sun (more particularly the mean latitude of the sunspot zones, one north and the other south of the sun's equator) to rotate once on its axis with respect to the earth moving in its orbit around the sun. Auroras likewise show this same recurrence tendency in a period of twenty-seven days. (3) A statistical relationship existing between the occurrence of individual sunspots of great size and the occurrence of great magnetic storms and associated auroral displays. Specific cases of joint coincidences between great sunspots, great magnetic storms, and unusual auroral displays witnessed in the south of England include those of March 22–23, 1920; August 9–10, 1917; November 17, 1882; August 28 and September 2, 1859, the last being associated with the unique observation, made by Carrington and Hodgson, of a transitory bright spot on the sun seen in integrated light with an ordinary telescope. At the commencement of a great

magnetic storm, the associated sunspot is found on the average about one day past the sun's central meridian. This asymmetry with respect to the central meridian is thought to be indicative of the time of travel required for the solar agency to travel from the sun to the earth. An informative feature, often shown by great magnetic storms, is their abrupt commencement at the same time (U. T.), so far as can be determined at widely separated magnetic observatories.

Apart from these special disturbances in the earth's magnetic field, illustrated by the recent aurora and magnetic storm, mention should be made of the high degree of accordance between curves of some solar index (say, smoothed mean daily areas of sunspots for each month) and curves similarly prepared which give the mean daily ranges of the earth's magnetic elements, *D*, *H* and *V*, after the seasonal inequality has been eliminated. No other known terrestrial phenomenon gives such detailed accordance with the observed periodic curve of solar activity.

To revert to the coincidences shown statistically by individual sunspots of first magnitude and great magnetic storms, it should be noted that as we proceed to the lesser sunspots and lesser magnetic storms, the relationship becomes less and less evident, and one concludes that the solar disturbances primarily related to the magnetic storms and associated auroras do not always produce a visible marking on the sun such as a sunspot. This point is clearly brought out in "time-pattern" diagrams prepared by J. Bartels to show synchronous or nearly synchronous solar activity and magnetic activity on the earth. The occurrence of the recent aurora is also an anomaly. Between January 12 and 24 a very large sunspot crossed the sun's disk. Magnetic storms were recorded in Great Britain commencing on January 16 and 22, and there were reported auroras in Canada. On January 25, when the great auroral display was seen, the big sunspot had been carried out of view by the sun's rotation. A spectroscopic examination of the sun's disk naturally suggests itself, but so far no distinctive phenomena have been reported which could reasonably be associated with the aurora and magnetic storm.

Characteristic features of the aurora itself have been investigated by studying (1) typical forms, (2) geographical distribution (annual and diurnal frequencies), (3) height above the earth's surface, (4) the characteristic spectrum. A useful collection of auroral photographs enabling the observer to identify typical forms is given in a "Photographic Atlas of Auroral Forms" published in 1930 by the International Geodetic and Geophysical Union. As is well known, the zone of maximum auroral frequency roughly circles the earth's magnetic poles in magnetic latitude 67° (the position of the north magnetic pole being in geographical longitude 96° W. and latitude 70½° N., and that of the south magnetic pole in longitude 151½° E., and latitude 71½° S.). Thus for places in the same geographical latitude, Canada is, for instance, more favourably placed for observing polar auroral phenomena than is Great Britain.

The association of magnetic disturbance with the aurora was first remarked by Halley in 1716; but as already noted, the association is not a simple one; auroras have been observed in the absence of marked magnetic disturbance and vice versa. Near the auroral zone itself, the frequency data of auroras fail to show a marked peak corresponding with solar maximum such as is given by the frequency curves of magnetic storms and auroras recorded in lower magnetic latitudes. It has been suggested by Vegard that the generally increased magnetic disturbance near sunspot maximum is instrumental in conveying auroras from the auroral zone to lower latitudes, thus reducing the frequency in the auroral zone itself. This suggestion finds corroboration in the results of a comparison made, by A. Röstad, between the position of auroral displays observed in Trondhjem, Oslo and in Holland and the intensity of the simultaneous magnetic storms recorded at Potsdam. Theoretical and practical investigations by Birkeland and Størmer have shown that if the earth encounters a beam of electrified particles, then the particles will be deflected by the earth's general magnetic field into two zones (to be identified with the auroral zones) one in the northern and the other in the southern hemisphere. The nature of these streams of particles has been the subject of several more recent investigations by Størmer, Chapman, Lindemann, Milne, Vegard, and others. Although the precise nature of the streams is undetermined, it would seem that they must consist of electrified particles of considerable energy so as to penetrate the earth's atmosphere to the lower observed limit of the aurora (about 70 km.). It will be noted that the deflected corpuscles are able to come down on the night side of the earth, the diurnal distribution of the aurora showing a pronounced maximum near midnight, reckoned with respect to the earth's magnetic axis.

The determination of the height of auroras has in recent years been made systematically by measuring the angular displacement of distinctive features of a particular aurora against the background of bright stars, as recorded on two simultaneous photographs taken at opposite ends of a long base line. Eventually it should be possible to decide whether the aurora ever comes down to very low levels as is sometimes reported.

The average height of the lower limit is about 106 km.; there is greater scatter for the upper limit, which shows some dependence upon type and distribution of light intensity along the streamers. The near coincidence in height between the average lower level of the aurora and that of the *E*-layer explored by radio-echo observations would appear to be other than fortuitous.

The spectrum of the aurora long presented great difficulty, and although important advances have been made, knowledge of the origin of the spectrum is by no means complete. In 1925, the well-known prominent auroral green line at 5577 A. (discovered by Angström in 1866) was proved by McLennan and Shrum in their laboratory in Toronto to be due to oxygen in a metastable state. The great intensity of this line is explained by Vegard as being due to oxygen excited to emit this radiation by means of collisions of the second kind with activated nitrogen. Besides the prominent green line, there are two lines in the red, at 6300 A. and 6365 A., both of which are thought to be due to oxygen. In addition, the visual spectrum is characterized by the negative band spectrum of nitrogen. A phenomenon of great interest, studied in particular by Lord Rayleigh, is the light of the night sky, the spectrum of which shows the same green radiation at 5577 A. as does the aurora, although the negative band spectrum of nitrogen is missing. Babcock accurately derived the wave-length as 5577·35 ±0·01 A. It has been suggested by Rayleigh (*Proc. Roy. Soc.*, A., **106**, 135) that the light from the non-polar aurora (as represented by the night sky luminescence found generally distributed over the world) is of a phosphorescent nature, the luminosity being excited by the sun during the daytime and carried round by the earth's rotation. It is important to note the distinction between the non-polar aurora and the polar aurora as exemplified by the recent display.

In conclusion, mention may briefly be made of the work of solar observers in trying to identify the precise phenomenon on the sun responsible for the occurrence of magnetic storms and their associated auroras. Replicas of Dr. Hale's spectro-helioscope, perfected by him in 1926, have been systematically used by a number of observatories in searching for and recording bright chromospheric eruptions which might, it was thought, be related to perturbations in the earth's magnetic field. Although no definite progress can be claimed in obtaining observational evidence of corpuscular streams (the search for which had been urged by Chapman), a new relation has been brought to light in which the solar agency appears to be radiation in the ultra-violet. There is now little doubt that sudden bright chromospheric eruptions (usually near sunspots) visible in $H\alpha$ with the spectrohelioscope or on Ca^+ spectroheliograms produce an immediate (that is, within about the time taken for light to reach the earth from the sun) disturbance in the ionosphere over the sunlit hemisphere, apparently just below the *E*-layer. At the same time, relatively small magnetic perturbations may occur, the effect of which is recorded within a limited distance from the place where the sun is in the zenith at the time of the solar eruption. These small disturbances in the earth's magnetic field are, however, clearly to be distinguished from the magnetic storms and auroras considered above, which are essentially high lattitude phenomena.

Obituary Notices

Prof. W. H. Pickering

PROF. W. H. PICKERING died on January 21 at his home at Mandeville, Jamaica, at the age of seventy-nine years, after several months of failing health. He was a younger brother of E. C. Pickering, the director of the Harvard College Observatory from 1876 until 1920.

Born at Boston in 1858, Pickering graduated at the Massachusetts Institute of Technology in 1879, and became a lecturer there, and at the same time was an assistant professor at the Harvard College Observatory. His first astronomical observations were at the eclipse of 1878, where he observed the radial polarization of the corona. For a time he was in charge of the Harvard College Observatory Station at Arequipa. Vol. 33 of the *Harvard College Annals* contains his researches on the determination of photographic stellar magnitudes, the Great Nebula in Orion and visual observations of the moon and planets.

In 1900 Pickering established the Harvard College Observatory at Mandeville, and while there published a lunar atlas from photographs taken with a 12-inch lens of focal-length 135 ft. The disk of the moon is divided into sixteen parts, and each part photographed under five different illuminations. In 1898 he discovered by photography a small satellite of Saturn at a distance of 8 million miles from the planet and revolving round it in a year and a half. This satellite, to which he gave the name Phœbe, is remarkable in that it revolves in a direction contrary to the other eight satellites, a peculiarity which was later found in three faint satellites of Jupiter.

At Mandeville, Pickering continued his visual observations of the moon and planets. He observed Mars under good climatic conditions and was satisfied of the existence of the "Canals" and drew the more important ones in agreement with Lowell. He regarded them as belts of vegetation of widths up to 150 miles along assumed water courses. In 1921 he

challenged the view taken by astronomers that the moon was dead and that no changes took place on its surface in a paper contributed to the Royal Astronomical Society on "Seasonal Changes occurring in certain Lunar Craters". These he attributed to patches of snow which disappeared gradually and reformed. These changes have not been confirmed, and must be attributed to differences of definition.

Pickering, Percival Lowell and George Forbes all made calculations to discover an extra-Neptunian planet. Pickering used the slight deviations of the orbit of Uranus, Lowell and Forbes the slight deviation of the orbit of Neptune (and in the case of Forbes the existence of a so-called family of Neptunian comets), as data for the existence of this body. The position of the planet was found by both Pickering and Lowell from these wholly insufficient data, and strangely enough a planet was found by Tombaugh at the Lowell Observatory on January 21, 1930. Judging from its brightness, the mass of the planet is too small to exercise any appreciable perturbation on Uranus or Neptune.

Prof. Pickering married Anne Atwood, daughter of Mr. Isaac Butts of Boston. They visited England a number of times and made many friends. Prof. Pickering spoke several times at the Royal Astronomical Society, of which he was elected an associate in 1910. He has also addressed the British Astronomical Association, as he was greatly in sympathy with amateur observers. F. W. D.

WE regret to announce the death of Sir James Crichton-Browne, F.R.S., a pioneer in the treatment of mental disease, which occurred on January 31, aged ninety-seven years.

News and Views

Mr. W. M. H. Greaves

THE King has approved, on the recommendation of the Secretary of State for Scotland, the appointment of Mr. W. M. H. Greaves, chief assistant of the Royal Observatory, Greenwich, to be astronomer royal for Scotland and professor of astronomy in the University of Edinburgh, in succession to Prof. R. A. Sampson, who retired recently. Mr. Greaves entered St. John's College, Cambridge, in 1917. He obtained a first class with distinction in Part II of the Mathematical Tripos and was awarded the Tyson Medal for astronomy. He obtained a Smith's Prize in 1921 for an essay on the movement of asteroids of the Trojan group, was awarded an Isaac Newton Studentship and in 1922 was elected a fellow of his College. Mr. Greaves was appointed chief assistant at the Royal Observatory, Greenwich, in 1924. The most important work undertaken by Mr. Greaves at Greenwich has been the development of methods for the determination of the colour temperatures of stars. The observations are divided into two parts: the determination of the relative gradients of the spectral energy curves and the fixing of the zero point of the temperature scale. The determination of the zero point is a long and intricate investigation, requiring reference to a terrestrial source; it has been undertaken twice with concordant results. The mean colour temperature for stars of spectral type *A*0 was found to be 18,000° K.; this value is appreciably higher than had previously been accepted but has since been confirmed by other investigators. Mr. Greaves has also been in charge of the magnetic work at Greenwich and has made some valuable investigations of the relationships between sunspots and magnetic storms. Mr. Greaves was secretary to Section A (Mathematics and Physical Science) of the British Association from 1924 until 1931, and has been secretary of the Royal Astronomical Society since 1932.

Accident to Dr. W. W. Vaughan

MOST of the members of the British Association delegation to the jubilee meeting of the Indian Science Congress Association have now returned, and one of them has kindly told us the circumstances of Dr. W. W. Vaughan's lamentable accident at Agra. It appears that Dr. Vaughan, with Mrs. Vaughan and other members of the delegation, had gone to the Taj Mahal before moonrise on the night of the party's arrival at Agra. In the darkness, he missed his footing on the upper of two terraces between which there is a fall of several feet, without any parapet. He fell on to the lower terrace, and his leg was broken above the knee. Help was obtained from other members of the delegation, and also, very fortunately, from an Indian friend of one of them, who, as a resident in Agra, knew what to do. But there was a weary wait for the sufferer before an ambulance could be got, during which he retained both consciousness and, by all accounts, the bravest bearing. The Thomason Hospital at Agra received him with every attention. It is now known that the leg, which had not been healing satisfactorily, was amputated on Monday, January 24; a private message on the following Thursday spoke of the patient's condition as "improving", and a press bulletin on January 31 appeared equally favourable.

International Economic Collaboration

THE able report by M. Van Zeeland on his mission of inquiry to various countries, directed to "the possibility of obtaining a general reduction of quotas and of other obstacles to international trade", was published in the press on January 28. His proposals in the main are very much in line with views that have been repeatedly expressed in NATURE, and they should receive serious consideration by all Governments. His immediate object is to bring together

representatives of the principal economic Powers—in particular, Great Britain, the United States, France, Germany, and Italy—in the hope that they may succeed in working out an agreed plan of international economic collaboration. That there is ground for this hope is clear from the fact that everywhere he went M. Van Zeeland tells us that he met with a most sympathetic reception. The report he has so carefully prepared should provide an excellent basis for discussion. It is well balanced, stating frankly the difficulties which have to be faced without being too caustically critical of the narrow nationalistic aims recently pursued by nearly all countries.

Among the more fundamental problems for which a solution must be found, two in particular have received a good deal of advertisement, different countries advocating claims and counter-claims in regard to them, namely, those which relate to raw materials and colonies. It is highly important that such problems should be approached, as M. Van Zeeland urges in his report, "in a spirit of complete objectivity". That is a sound principle which every man of science will be ready to endorse. As to colonies, the most promising line of attack seems to be, again quoting the words of the report, "to seek for the means of generalizing the system of the open door which obtains in the Conventional Basin of the Congo, a system the general result of which it is impossible to criticize". So long as colonial Powers are in a position to exercise monopoly rights in the areas they control, dissatisfaction is bound to remain in the minds of those ruling the nations that are shut out, and such dissatisfaction is the potential seed of war.

Niagara Falls Bridge Disaster

The well-known Niagara Falls View Bridge across the Niagara River, just below the falls, a steel-framed structure in a single span of about 1,200 feet, weighing some 2,600 tons and erected in 1898 at a cost of £60,000, collapsed during the afternoon of January 27, under the pressure exerted by an enormous mass of pack ice which had accumulated at the foot of the Falls. By reason of the intense cold of the preceding weeks, the ice had piled itself in huge blocks as it was swept over the Falls, to a height not much less than the deck level of the bridge, which was 165 feet above the river, and the danger had been clearly recognized for some time previously, so that when, despite the efforts made to save the bridge with heavy timber fenders, the final collapse took place, the sight was witnessed by a crowd estimated at ten thousand. The broken bridge now rests in a tangle of twisted steelwork upon the surface of the ice, which continues to gather and fills the gorge for a distance of two or three miles. There is another bridge for rail and road traffic about a mile and a half downstream, and this will have to be utilized for pedestrians until the fallen bridge is replaced. The drift of ice towards Lake Ontario is causing concern lest damage should be done to the generating station and plant of the Ontario Hydro-electric Commission, which is a short distance below the Falls. As it is, there is serious interference with the supply of electricity due to the fracture of mains.

Decibels and Phons

A correspondent has raised the question of the use of the decibel as a unit for expressing sound intensity. Since his difficulties are shared by others, it seemed worth while to place them before an authority on the subject, who has been good enough to deal with them. He points out that it is not always realized that the decibel is a unit for specifying changes in intensity, power, or energy, and not a direct measure of the absolute value of these quantities. Decibels are not additive, since they measure changes on a logarithmic scale; so that it is the ratio of two sound intensities which determines their difference in decibels. Two similar sounds of intensities I and I_0 are said to differ in intensity by n decibels when $n = 10 \log_{10} I/I_0$. Hence a 10-fold increase in the intensity of a sound is a 10 decibel change, a 100-fold increase a 20 decibel change, and a 1000-fold increase a 30 decibel change. A decibel corresponds to an increase of intensity or energy in a ratio of approximately 5/4, two decibels to a ratio of $(5/4)^2$, three to a ratio of $(5/4)^3 = 2$, . . . and so on. Thus doubling the intensity of a sound, as when two similar voices sing the same note, corresponds to a change of 3 decibels. When a sound is said to have an intensity of so many decibels, it is implied that the intensity is being compared with some intensity which has been selected as a zero level. An international conference held in Paris last July adopted an intensity corresponding to an acoustical pressure of 0·0002 dyne per sq. cm. as the reference zero, this being near the threshold of hearing for sounds with frequencies in the neighbourhood of 1000 cycles per second.

It will be seen that the decibel is a purely physical unit and is independent of the characteristics of the ear, which assesses loudness and not intensity. Moreover, two sounds of the same intensity but of different quality will not necessarily appear to be equally loud. For comparing the loudness of sounds, a scale of phons has been set up, based upon the fact that individuals find it possible to judge whether sounds of differing quality produce a sensation of equal loudness. Any sound or noise is matched under specified conditions against a pure reference tone with a frequency of 1000 cycles per second. If the intensity of the reference tone in decibels above the zero level is n, the reference tone and the sound or noise are said to have an equivalent loudness of n phons. For sounds of medium frequency and moderate loudness, a phon happens to correspond roughly to the smallest difference of loudness which can be detected by alternate listening under ordinary conditions.

Educational Science at Cambridge

The recommendations of the Special Syndicate at the University of Cambridge on the position of the

University Training College for Schoolmasters are of far-reaching importance and, if carried into effect, may have great influence on the development of educational methods. The Syndicate recommends the creation of a professorship of education and the establishment of a Department of Education in the University. The last Royal Commission on the University recommended that such a professorship should be founded, and the Syndicate advances cogent reasons why it is particularly opportune for the chair to be founded at the present time. The systematic study of educational problems, especially in so far as psychology bears on these, has advanced in no uncertain manner during recent years, and it is vitally important for the University to be intimately concerned with these developments; only thereby can it exercise due weight in the educational progress of the nation. To obtain a person of sufficient initiative, experience and prestige, the Syndicate considers that the head of the Department of Education should have the status of professor, as is the case in certain other universities.

£750,000 Claim against the University of Oxford

IN Congregation at Oxford on February 1 the Vice-Chancellor announced that the claim of the company which has been suing the University for £750,000, following the conviction of B. J. Owen, formerly director of the Institute for Research in Agricultural Engineering, had been settled by a payment by the University of £70,000. This ends satisfactorily, it may be said, a trouble that has been threatening the University off and on during the past seven years. It began in 1926, when the director of the Institute for Research in Agricultural Engineering sold to the plaintiff company patents relating to the extraction of sugar from beet which were stated to be novel and excellent but which proved to be worthless. The company believed that the director was acting throughout as agent of the University and that the representations he made in that capacity resulted in the loss by the company of much of its capital. The necessity for this large payment is, of course, a serious blow to the University, but the money required will not be diverted from any of the funds for which appeals have been made in recent months.

The British Film Institute

THE British Film Institute has recently published its fourth annual report (1937). It is an interesting record of rapid development and growing usefulness. It is clear that the exploratory phase in the use of the film in education has passed and that the time has come to put into effect the lessons learnt. But it is disappointing to learn that a census recently carried out by the Institute showed that only 916 projectors are available in the educational institutions of Great Britain. This is fewer than one tenth of the number in use in the United States, Germany, France, Italy, etc. Both the Board of Education and the local education authorities are concerned at this slow progress, and are doing their best to encourage teachers to make more use of visual material. The Board of Education is now willing to pay 50 per cent of the cost of any projectors installed. Among the numerous publications sponsored by the Institute in 1937, one is of special interest to teachers of science—the report prepared by the Science Panel. This contained, besides advice on technique of use, etc., a list of 455 science teaching films. Two thirds of these are concerned with biology—a subject well suited to visual presentation. It is unfortunate that so few films on physics and chemistry are available.

THE British Film Institute records that it is watching with close attention the work being done by the new cinematograph group of the British Standards Institution. This group is devising simple methods of testing the effective light output of projectors and is framing regulations for the use of non-flam films. The National Film Library, which now contains 268 films, is growing very slowly—shortage of funds is a great handicap. Recently the Library received a valuable gift from the Paisley Philosophical Society: a collection of films exhibited in 1901, which had been put away and apparently forgotten. These films are still in good condition though they need refixing and rewashing. It is interesting to note that the use of films in education is growing rapidly in other parts of the Empire: Canada has set up a National Film Society, the Minister of Education of South Africa has founded a Film Division, in East Africa a film library is to be set up, at Achimota College (Gold Coast) a library has been started. In all these cases, the co-operation of the Film Institute has been secured.

London School of Hygiene and Tropical Medicine

IN the report on the work of the London School of Hygiene and Tropical Medicine for the year 1936–37, the Board of Management notes that Mr. Neville Chamberlain has accepted the chairmanship of the Court of Governors vacant through the death of Sir Austen Chamberlain. The Dean of the School, Prof. W. Jameson, reviews the teaching and research work of the various departments. A course on mental deficiency, designed to enable medical practitioners to secure recognition by the Board of Education as certifying officers under the Mental Deficiency Acts so far as elementary school children are concerned, was held in the School for the first time in February, and proved an unqualified success, all available places being filled. Dr. Hamilton Fairley and Mr. R. J. Bromfield spent six weeks in Macedonia studying blackwater fever, and confirmed the presence of a new pigment, 'pseudo-methæmoglobin', in the blood in that disease. In the Department of Entomology investigations have been pursued into the production of satisfactory anti-larval oils for the destruction of mosquito larvæ in malaria control, and on the biology of the bed-bug. Sir Malcolm Watson contributes the report of the Ross Institute of Tropical Medicine, now incorporated in the School. He directs attention to the importance of agriculture in the tropics and of teaching health officers practising there the principles of farming. Workers abroad are

largely concerned with the prevention of malaria, and in Northern Rhodesia they had been able to reduce the mortality from this disease among the European workers in the copper mines from 22 to 9, and among the natives from 31 to 5, per 1,000.

Meteorological Service for Indian Air Routes

"METEOROLOGICAL ORGANISATION FOR AIRMEN, 1937", is the title of a pamphlet compiled under the direction of Dr. C. W. B. Normand, Director-General of Observatories, India Meteorological Department, for the benefit of airmen flying anywhere between the Persian Gulf and Burma (Delhi: Manager of Publications. 2*s*. 3*d*.). It describes the organization maintained by the India Meteorological Department on behalf of aviation, the nature of the information about current weather that is obtainable from that organization, and all that an airman requires to obtain that part of the information which he may require on any flight. Full information in regard to the latter must include the addresses and telephone numbers of officers responsible under the Director-General for particular parts of the whole area dealt with, their office hours, and the times at which they complete synoptic weather charts, if the airman is to make the most of the information available. It may be noted, however, that on the trans-India air route between Karachi and Victoria Point, Burma, the issue of different kinds of meteorological message by wireless to all the main aerodromes has been organized on a routine basis and the latest information can be obtained from weather notice boards at such aerodromes; alternatively, it can be obtained by the airman by wireless while he is in flight. All these points are systematically treated in a series of tables that occupy most of the pamphlet, and among these tables are the very important ones that explain the different codes which make it possible to condense much information about actual and expected weather into telegrams or wireless messages. There is a key map showing the positions of the various types of meteorological station, and the boundaries of the different forecast areas and provinces. The organization embraces the whole of Baluchistan and Burma as well as India.

Royal Scottish Society of Arts

THE Royal Scottish Society of Arts is, like its prototype the Royal Society of Arts, one of the few unspecialized learned societies. It draws together men engaged in the pursuit of applied science and art of the most diverse kinds. In a prospectus just issued, this peculiarity is emphasized, and it will doubtless be accounted to the Society for righteousness by those who set a high value on general culture. The principal objects of the founders were "to stimulate and reward genius and mechanical industry and to afford a ready and useful medium of intercourse among men of all ranks who were engaged either in the pursuit of Science or in the various practical departments of the Arts and Manufactures". During the winter session there are fortnightly meetings at which papers are read, and a course of special lectures on a subject of general interest is given by a selected specialist. Prizes are offered for inventions and communications. The Council desires to suggest, especially to prospective student members (for whom the annual subscription is only 5*s*. up to the age of twenty-three years) that attendance at the ordinary meetings and participation in discussions provides an extremely easy and really valuable means of extending their general and technical education. Evidently a complete survey of adult education would not ignore the opportunities offered by this Society.

Modern Sylviculture

IN an article entitled "Revue de Sylviculture", published originally in the *Revue generale des Sciences pures et appliquees* (48, No. 7, April), Prof. H. Perrin deals with the practice of modern sylviculture more especially from the French point of view. He points out that in former times the forest was regarded solely as a source of supply of timber and smaller materials, on the supposition that such supplies would continue inexhaustible. Latterly, he says, there has been a swing-back, in some quarters, to this point of view. He pleads for a return to, or a continuance of faith in, the sylvicultural principles laid down by the old masters of the science or art, of whom the last century provided some of the best known. Perrin deals with the various aspects of, and factors influencing, sylvicultural practice, and details in a general manner French methods. A close acquaintance with the forest is not easy to acquire, owing to the fact that the methods of investigation common to all the biological sciences are difficult of application in the forest; long years of observation must be passed during which generations of men succeed each other; and only continuity and persistence will result in that sylvicultural knowledge and practice which is the antithesis of the 'get rich quick' theory as applied to forest management, which has made its appearance of late years in places.

The R.H.S. Lily Year-Book

CONTRIBUTIONS from the point of view of the practical gardener predominate in the Royal Horticultural Society's Lily Year-Book for 1937 (from the Society's Office, Vincent Square, Westminster, S.W.1, 5*s*. paper; 6*s*. cloth; pp. 153. Oct. 1937). Information upon the choice of lilies for all situations in the garden can be found in it, and the increasing popularity of *Nomocharis* and fritillary is reflected by several articles on these genera. Dr. W. B. Turrill contributes a useful taxonomic study on fritillaries, giving detailed descriptions of anatomy. A report of discussions upon the propagation of lilies from scales provides much practical information. Two papers, by Dr. Fred Stoker and F. C. Stern, compare lilies which will grow on lime-free and lime soil respectively. No sharp distinction can be drawn between the lily flora of these two horticultural habitats, and the absence of more scientific experiments leaves a doubt as to whether lime or some other influence is really the controlling factor. Mr. L.

Ogilvie describes experiments upon the depth of planting, and the effects of high and low temperatures, on lily bulbs. One cannot escape the conclusion, however, on considering the contents of the present volume, that it deals with less fundamental questions than previous issues.

Leeds College of Technology

ON the occasion of the distribution of prizes and certificates by Sir William Bragg on December 7, the principal of the Leeds College of Technology presented a report on the work of the last session, emphasizing the value to the local industries of the thoroughly up-to-date technical instruction given in the College to more than three thousand of their personnel. The total number of students was 3,862, of whom 3,320 attended evening classes only and 375 attended part-time day and evening classes. Although education authorities are often inclined to disparage evening classes on the ground that after a hard day's work people cannot be expected to be fit for serious study, they are nevertheless a very valuable part of the country's educational resources. As the principal points out, they are, moreover, capable of exerting a definitely beneficial effect on character: "To attend evening classes regularly after the day's work, for several sessions, each of which includes an English winter, is an indication of grit and perseverance in addition to intellectual ability". It is noteworthy that 379 students were released by employers to attend part-time day classes, generally in addition to evening classes.

Vocational Guidance

A 'VOCATIONAL GUIDANCE' pamphlet has been issued by the University College of the South-West of England, Exeter, for the use of parents and others. It gives a list of the various college courses with particulars of their duration and the fees payable for them, a list of vocations (other than teaching) for which the courses offer suitable preparation, and a list of other vocations. The attention of parents is directed to the fact that in some cases the course of study is of one year's duration only and entails no long or expensive training. Accompanying the pamphlet is a leaflet directing attention to the increased demand for scientific investigators both for routine and research duties, to the importance for entry into commerce or industry of good qualifications in modern languages and economics, and to a new course for a diploma in public administration. This diploma will, it is anticipated, be a valuable qualification for higher posts in the national and local government services.

The Laxminarayan Technical Institute, Nagpur

THE foundation stone of the Laxminarayan Technological Institute was laid by His Excellency Sir Hyde Clarendon Gowan, Chancellor of the Nagpur University, at Nagpur on December 8, 1937. The Chancellor paid great tribute to the untiring efforts of the present Vice-Chancellor, Sir Hari Singh Gour, in acquiring the present site for the Institute, which will be surrounded by charming scenery. The construction of the Laxminarayan Technological Institute and its workshop is the result of a princely bequest, now amounting to more than £400,000, made by the late Rao Bahadur D. Laxminarayan in 1930 to the University of Nagpur for the teaching of applied science and chemistry. The University has decided to begin with the creation of a department of applied chemistry for teaching and research work in this subject. Dr. R. S. Thakur, who had been deputed for the last two years by the University of Nagpur to visit England and the continent of Europe for practical training in applied chemistry, with special reference to oil technology, has now been appointed as the organizing officer. It is expected that the Institute will be in active operation about July of next year.

Refrigeration Conference

A REFRIGERATION Conference will be held in London on July 12, in the rooms of the Royal Society. This Conference, which is convened by the British Association of Refrigeration, will take place immediately following a meeting at the same centre of the Technical Commissions of the International Institute of Refrigeration, an organization with headquarters in Paris. The subjects provisionally set down for discussion at the Conference, which will be open to all technicians interested in refrigeration, are: influence of low temperatures on enzymes, vitamins, etc.; limitations of 'gas storage'; air conditioning problems; an international unit of refrigeration; standard tables giving the properties of refrigerants. Further information can be obtained from the Hon. Secretary, British Association of Refrigeration, Empire House, St. Martin's-le-Grand, London, E.C.1.

Mathematical Colloquium at St. Andrews.

A MATHEMATICAL colloquium, similar to the very successful gatherings held in 1926, 1930 and 1934, will be held in St. Andrews on July 4–July 15, 1938, under the auspices of the Edinburgh Mathematical Society. Short courses of lectures will be given by prominent mathematicians, including Prof. E. T. Whittaker, Prof. G. D. Birkhoff, Dr. A. C. Aitken, on topics of pure and applied mathematics. On their way to the colloquium, members will have the opportunity of attending a meeting of the Royal Society of Edinburgh, celebrating the three hundredth anniversary of the birth of James Gregory, who held in succession the chairs of mathematics in the Universities of St. Andrews and Edinburgh. This meeting will be held in Edinburgh on July 4. Further particulars of membership of the colloquium can be obtained from the Hon. Secretary, Edinburgh Mathematical Society, 16 Chambers Street, Edinburgh 1.

The Night Sky in February

FULL moon occurs on February 14 at $17{\cdot}2^h$ and new moon on March 2 at $5{\cdot}7^h$ U.T. No occultation of stars brighter than magnitude $5\frac{1}{2}$ occurs this month.

The moon is in conjunction with Saturn on February 4 at 18^h and three hours later with Mars, the two conjunctions illustrating very well the moon's movement in its orbit around the earth. Mars was in conjunction with Saturn on February 2 at 20^h, and the former continues to move eastwards relative to the latter. Those observers interested in the phenomena of Saturn's satellites should consult p. 30 of the B.A.A. Handbook for the times of eclipses, occultations and transits. The apparent diameter of the minor axis of the ring system is slowly increasing up to a maximum of 8″ in August next. Uranus (6th magnitude) is not far from 29 Arietis, a star of similar magnitude. Neptune is in Leo, and at the end of February is about half-way between 89 Leonis and σ Leonis; the disk presented by the planet is 2½″ in diameter. The well-known eclipsing binary, Algol (β Persei), is becoming less favourably placed for observation. The change in brightness (in 5 hours the star loses two-thirds of its light and then returns to its original brightness in the following 5 hours) can be seen best about 1½ hours before and after the following epochs: February 6^d $23{\cdot}8^h$; 9^d $20{\cdot}6^h$; 12^d $17{\cdot}4^h$; 24^d $4{\cdot}7^h$, 27^d $1{\cdot}6^h$ and March 1^d $22{\cdot}4^h$. In view of the occurrence of magnetic storms commencing on January 16, 22 and 25 (the latter being associated with the great auroral display), it may be worth while watching the northern skies 27 days after each of these dates, especially on or about February 21, when the moon will be absent until after midnight. Analysis of data shows, however, that great magnetic disturbances recorded in this country are much less likely to recur after one synodic solar rotation than those of lesser intensity.

Announcements

THE King of the Belgians has conferred upon Prof. H. S. Taylor, professor of physical chemistry in Princeton University, the Cross of Commander of the Order of Leopold II in recognition of the services rendered by him to Belgium as occupant of the Francqui chair at Louvain in chemistry from January until June of last year.

PROF. A. B. WASICKY, professor of pharmacognosy in the Pharmaceutical Institute of the University of Vienna, was awarded the Hanbury Medal for 1937 of the Pharmaceutical Society of Great Britain and the medal will be presented to him on February 8, when he will deliver a lecture entitled "Modern Points of View and Methods in Pharmacognosy".

MISS JEAN BATTEN has been awarded the Gold Medal of the International Aeronautical Federation. The award was made for the greatest flying achievement of 1937. There were twenty-two nations represented at the Federation's conference, at which the Royal Aero Club represented Great Britain.

THE prize of £100, founded by Viscount Cecil of Chelwood, which is offered yearly for an essay on some subject connected with the maintenance of international peace, and is open to all students, without distinction of sex or nationality, of any university or university college in Great Britain or Northern Ireland, has been divided between Miss Ursula Wasserman of the University of London and Mr. D. D. Hindley-Smith of the University of Cambridge. The subject for the year 1937 was "The Causes of the Failure of the Disarmament Conference".

THE ARCHBISHOP OF YORK (Dr. William Temple) has accepted an invitation to act as president of the Society for the Protection of Science and Learning, formerly the Academic Assistance Council, in succession to the late Lord Rutherford.

PROF. N. V. SIDGWICK will deliver the distinguished visitor's address of the Chemical Society of Birkbeck College, on February 14, at 6 p.m. The title of Prof. Sidgwick's address is "Multiple Links". Admission is free, without ticket.

DR. NANNA SVARTZ-MALMBERG, who is well known for her work on intestinal bacteria and their influence on rheumatic diseases, has been appointed professor of medicine at the Stockholm Caroline Institute by the Swedish Government. This is the first time that a Swedish woman has been appointed professor.

A DISCUSSION on the Ministry of Health new model building by-laws will take place at the Royal Sanitary Institute, 90 Buckingham Palace Road, S.W.1, on February 8 at 5.30 p.m.

AN international conference of teachers to discuss the actual problems of international relations to-day and to exchange ideas and experiences on the methods of teaching international relations and of promoting international friendship and understanding in the colleges and schools will be held in London on April 22–25. Further information can be obtained from the Secretary, Education Committee, League of Nations Union, 15 Grosvenor Crescent, London, S.W.1.

THE Department of Mines and Resources, Mines and Geology Branch, National Museum of Canada, has available a number of reports comprised in a series dealing with the Canadian Arctic Expedition, 1913–18. Many of the publications include half-tone illustrations and maps, and copies will be supplied without charge on application to F. C. C. Lynch, National Museum of Canada, Ottawa, from whom a list of the publications available can be obtained.

ERRATUM. In the letter entitled "Westward Extension of the Ranikot Sea" (NATURE, Jan. 29, p. 202) by Lieut.-Colonel L. M. Davies, the names of species appearing in lines 5 and 6 of paragraph 2 should read as follows: *Operculinoides* cf. *sindensis* (Davies), *Miscellanea stampi* (Davies), *M. miscella* (D'Arch. and Haime).

Letters to the Editor

The Editor does not hold himself responsible for opinions expressed by his correspondents. He cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 250.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Light Scattering and Fluid Viscosity

ACCORDING to well-known hydrodynamical theory[1], plane waves of sound propagated through a viscous liquid suffer a diminution of amplitude in the ratio $1/e$ in traversing a number of wave-lengths given by the quantity $3C\lambda/8\pi^2\nu$, where C is the velocity of sound, λ is the wave-length of sound and ν is the kinematic viscosity. Taking $\lambda = 4358$ A., this number for various common liquids which are fairly mobile at room temperature ranges from about 3 in the case of butyl alcohol to about 30 in the case of carbon disulphide. For phenol at 25° C., the number is less than 1, and for glycerine, it is a small fraction of unity. A consideration of these numbers shows that the theories due to Einstein[2] and L. Brillouin[3], which regard the diffusion of light occurring in liquids as due to the reflection of light by regular and infinitely extended trains of sound-waves present in them, can only possess partial validity for ordinary liquids, and must break down completely in the case of very viscous ones. In an earlier note in NATURE[4], we reported studies of the Fabry-Perot patterns of scattered light with a series of liquids, which showed clearly that the Doppler-shifted components in the spectrum of scattered light fell off in intensity relatively to the undisplaced components, with increasing viscosity of the liquid.

We have now to report some further results which illustrate in a striking way the part played by fluid viscosity in the diffusion of light by liquids. As mentioned in our previous note, the light scattered by liquid phenol at ordinary temperatures gives a Fabry-Perot pattern which is scarcely distinguishable from that of the incident light. When, however, the temperature of the liquid is raised, the viscosity falls off rapidly, and the number $3C\lambda/8\pi^2\nu$ assumes a value which is many times greater than at room temperature. Simultaneously, as can be seen from Fig. 1, the character of the Fabry-Perot pattern alters, and the Doppler-shifted components come increasingly into evidence; at 70° C. they are just as prominent as in ordinary inviscid liquids. The influence of temperature revealed by these studies for the case of the very viscous phenol is to be clearly distinguished from the broadening of the Doppler components with rise of temperature reported by us in an earlier note[4] for the case of carbon tetrachloride.

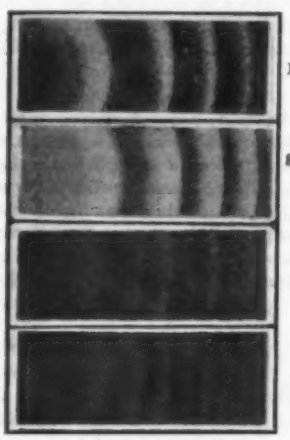


Fig. 1.
INFLUENCE OF TEMPERATURE ON THE SCATTERING BY PHENOL.

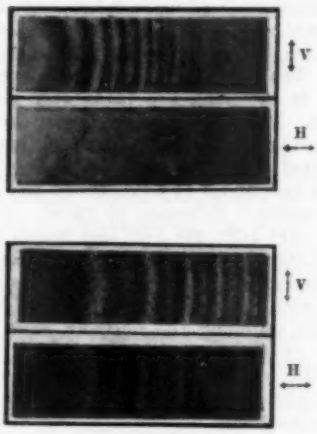


Fig. 2.
STATE OF POLARIZATION; ABOVE, TOLUENE; BELOW, PHENOL.

The four patterns reproduced in Fig. 2 show the remarkable difference in the state of polarization of the Fabry-Perot patterns of transversely scattered light for an inviscid liquid such as toluene and a viscous one such as phenol at room temperature. In the former case, only a continuous radiation is to be observed in the horizontal component; in other words, both the displaced and the undisplaced components in the pattern are sensibly completely polarized with the vibrations vertical. In the case of phenol, however, the undisplaced radiation is

evidently partially polarized, as it appears both in the vertical and the horizontal vibrations; a partial polarization of the continuous radiation is also noticeable.

C. V. RAMAN.
B. V. RAGHAVENDRA RAO.

Department of Physics,
Indian Institute of Science,
Bangalore.
Dec. 29.

[1] Lamb, "Hydrodynamics", fifth edition, p. 613.
[2] Einstein, A., *Ann. Phys.*, **33**, 1275 (1910).
[3] Brillouin, L., *Ann. Phys.*, **17**, 88 (1922).
[4] NATURE, **139**, 585 (April 3, 1937).
[5] NATURE, **135**, 761 (May 4, 1935).

New Phenomena Connected with Heat Flow in Helium II

SINCE publishing the preliminary measurements on thermal conduction in liquid helium II[1] which showed a variation of conductivity with temperature gradient, further data have been collected concerning the phenomenon.

It was noted that the conductivity appeared to increase as the bore of the conduction capillary decreased. It was then found that at very low temperatures (1·08° K.) small heat flows produced a rise in the level of the liquid in the closed bulb at the heated end of the capillary, instead of the fall caused by increased vapour pressure which was observed for higher heat flows. The apparatus was modified

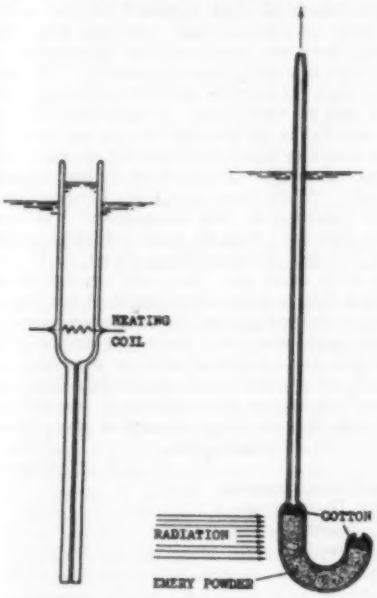


Fig. 1.

Fig. 2.

(Fig. 1) so that the top of the bulb at the hot end of the capillary was open to the vapour above the surface of the liquid helium bath. There was thus no possibility of a difference in vapour pressure between the liquid at either end of the capillary. As in the previous cases, heat was introduced electrically by means of a coil inside the bulb. On heating, the level of the liquid again rose in the bulb. The rise in level increased with increasing heat flow, and for constant heat flow increased with decreasing temperature. This effect opposes the effect of increased vapour pressure in the closed bulb, and thus will probably explain the apparent non-linear variation of heat flow with temperature gradient. More complete data on this phenomenon will be published later by one of us (J. F. A.).

A more striking manifestation of the above effect was observed by one of us (J. F. A.) in collaboration with A. D. Misener. Observations were being made on the flow of liquid helium II through a tube packed with fine emery powder (Fig. 2). The top of the tube was allowed to project several centimetres above the level of the liquid helium bath, and an electric pocket torch was flashed on the lower part of the tube containing the powder. A steady stream of liquid helium was observed to flow out of the top of the tube as long as the powder was irradiated.

Fig. 3.

The principle is the same as that for the thermal conductivity apparatus, in which heat is introduced electrically and flows through a capillary. Here the capillary is replaced by the minute interstices in the powder, and the heat input is obtained by means of the absorption of radiation by the powder particles. The apparatus forms, in effect, a very simple and efficient helium pump. The height of the jet becomes greater for lower bath temperatures and for powder particles of smaller size. A photograph of the liquid helium pump is shown in Fig. 3. The stream rises approximately 4 cm. above the jet, the top of the stream striking the side wall of the flask. The illumination for the photograph consisted of a 60-watt bulb, which also provided the radiant thermal energy for operating the helium pump. The maximum height of jet produced was 16 cm.

The significance of these results may perhaps be understood in the following manner. The observed specific heat of helium II shows that some co-operative phenomenon is concerned. According to Fröhlich[2], this is a disordering process analogous to that occurring in β-brass. Helium II is exceptional, however, in that almost the whole of the thermal energy at the λ-point is energy of disorder. We are led, therefore, to consider heat conduction as a flow of disorder rather than as a flow of vibrational energy. According to a suggestion of London's[3], the ordered state forms a diamond lattice which may be regarded as a body-centred cubic lattice in which only half the lattice points are occupied. According to Fröhlich,

the disorder arises when some atoms fill the unoccupied sites of this underlying body-centred structure. Such 'wrong' atoms would be able to jump from one possible site to the next. This model, admittedly naïve, contains an interesting feature, namely, that as the flow of disorder is weakened by collisions with the walls of the containing tube, momentum in the direction of flow is lost. This should be contrasted with conduction by vibrational waves which do not carry momentum. The reaction due to loss of momentum gives rise to a pressure in the opposite direction to the heat flow.

This process of conduction by flow of disorder has been considered in rather more detail by one of us (H. J., to appear elsewhere), and a second process by which a flow of disorder can be dissipated, namely, by interactions with vibrational waves, has been discussed. This latter process will not, of course, result in a 'back pressure'. This pressure will therefore be greater the greater the part played by the walls in the heat resistance. Lessening the bore of the tube in which heat flows, or filling with powder, increases, therefore, for a given heat flow, the magnitude of the back pressure.

J. F. ALLEN.
Royal Society Mond Laboratory, H. JONES.
Cambridge.

[1] Allen, Peierls, and Uddin, NATURE, **140**, 62 (1937).
[2] Fröhlich, H., *Physica*, **4**, 639 (1937).
[3] London, F., *Proc. Roy. Soc.*, A, **153**, 576 (1936).

Memories of Rutherford in Manchester

WHEN I look back on the five years which I spent with Rutherford as a young physicist in Manchester, many delightful impressions spring to my mind. I see his quiet research room at the top of the physics building, under the roof, where his radium was kept, and in which so much well-known work on the emanation was carried out. But I also see the gloomy cellar in which he had fitted up his delicate apparatus for the study of the α-rays. Rutherford loved this room. One went down two steps and then heard from the darkness Rutherford's voice, reminding one that a hot-pipe crossed the room at head-level, and that one had to step over two water-pipes. Then, finally, in the feeble light, one saw the great man himself seated at his apparatus, and straightway he would recount in his own inimitable way the progress of his experiments, and point out the difficulties that had to be overcome.

There was also a cheerful room upstairs, in which we all met for a cup of tea in the late afternoon. It was perhaps Rutherford's greatest gift to his young pupils and collaborators that he attended with such regularity this pleasant break in the daily routine. Here he would discuss in his lively manner old and new problems in physics, or help us in our experimental difficulties and give us renewed confidence, and here, to the delight of all present, he would so often relate details of his latest successes and discoveries. He might even take us along to his research laboratory and demonstrate to us something that he had himself seen for the first time that very day.

Rutherford always gave most willingly from his rich treasure-house of knowledge, at the same time never thinking of himself. I will mention one instance of this, which is still fresh in my memory. A young physicist who had just arrived in the laboratory commenced work on his research, and before long he was confronted by difficulties. Rutherford suggested to him a new line of attack, which would lead him in a simple and certain manner to a successful termination of his work. But the young man had not quite rightly grasped the significance of Rutherford's suggestions. From that moment, however, what he had heard continued to work on his subconscious self, and he understood gradually the trend of the proposals Rutherford had laid before him. When he saw quite clearly his new plan of action he was delighted, and immediately told Rutherford about these ideas, which he was convinced were his own. But Rutherford only smiled, and congratulated him in words of friendly encouragement on his new plan of work.

I always like to recall another little episode, which occurred at the time when much work was being done in the laboratory with sources of radiation consisting of extremely thin glass tubes filled with emanation. It was necessary to exercise great care lest any of this emanation should escape, for it spread rapidly throughout the building, and by virtue of its activity made experimental work an impossibility for periods of many hours. In his typically drastic manner, Rutherford had threatened the severest penalties for offenders in this matter. One day I noticed that it had become impossible to use an electroscope in my room, where I had fitted up the first counting experiments for Rutherford, and before long other research workers emerged from the neighbouring rooms with the same sad story. We were not long in discovering that the emanation had come from Rutherford's own laboratory, where at that moment he was actively engaged with his experiments. As luck would have it, he came into my room shortly afterwards, and inquired how my work was proceeding. He would have been glad to hear of new developments, but I was brief and to the point. I told him that once again it was futile to attempt to do any work, for the whole building was full of emanation, all of which came from his room. Rutherford looked surprised, and replied: "Well, there you have further proof of the power inherent in this emanation." With this remark he left me; but he soon returned, suggesting that I must be somewhat upset, and that I needed a little fresh air. He took me forthwith in his car for a ride beyond the turmoil of the city, and he was soon discoursing on his own experiments and on all the problems that were yet to be solved. Nothing was so refreshing nor so inspiring as to spend an hour in this way, alone with Rutherford. In spite of the minor provocation, I would be loth to part with the memory of such a day, spent in fellowship with a master-mind.

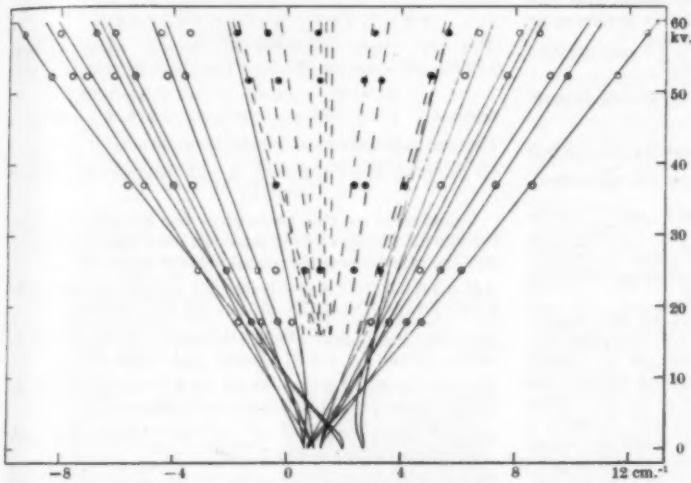
H. GEIGER.
Physikalisches Institut,
Techn. Hochschule,
Berlin.
Dec. 21.

Relativistic Stark Effect of Ionized Helium

THE problem of the relativistic Stark effect of hydrogen has been investigated mainly theoretically, the experimental investigation being hampered by great difficulties. These being less pronounced for the lines of ionized helium than for the hydrogen lines, I attacked the problem in question using the He^+ line λ 4686 A. This needed a stigmatic spectral apparatus of high resolving power coupled with great

brilliancy. A suitable large autocollimation glass spectrograph with two compound prisms was available, the total base-length of the flint prisms being 30 cm., and the focal length 150 cm. The dispersion in this region is about 2·5 A. per mm. As light source, I used a Lo Surdo tube as modified by Ryde.

Using the standard theory of the relativistic Stark effect of hydrogen, as worked out by Schlapp[1], I have calculated for the above line the displacements and relative intensities of the fine-structure lines for electric fields ranging from 0 to 100,000 v. per cm. The accompanying diagram is intended to give an idea of the theoretical displacements, the extensive numerical data being reserved for a detailed publication. Only those lines have been plotted the calculated intensities of which make them likely to appear on the plates. The theory shows that, in strong fields, most of the Stark components consist of several fine-structure lines the mutual distances



STARK EFFECT OF THE He+ LINE, λ 4686A. FULL LINES CORRESPOND TO *p*-COMPONENTS, BROKEN LINES TO *s*-COMPONENTS.

of which, apart from the second order effect, do not vary with the field. In weak and intermediate fields, that is, before the groups of fine-structure lines that constitute the ordinary Stark components have become separated, say, below 40,000 v. per cm., the theory draws a rather complicated picture that differs greatly from the symmetrical appearance of the ordinary hydrogen pattern.

It has been possible to observe a number of fine-structure lines, or groups of such lines overlapping each other, in different fields ranging from 0 to 100,000 v. per cm. If the field is not very weak, the measurements are in good agreement with theory, as will be seen from the diagram, where some experimental values above 18,000 v. per cm. have been plotted. In weak fields the position is not quite clear, and corresponding measurements will be published later.

B. KULLENBERG.

Physical Institute,
University, Lund.
Dec. 17.

[1] *Roy. Soc. Proc.*, A, **119**, 313 (1928). For further literature, see Kullenberg, B., *Z. Phys.*, **102**, 423 (1936).

Bode's Law and Saturn's Satellites

THOUGH no satisfactory physical explanation has yet been found for Bode's law of the approximately regular progression of the mean distances of the planets from the sun, the law holds good for all the planets except Mercury and Neptune and should not, therefore, be regarded as merely a coincidental truth. If the distance of Mercury itself from the sun is left out of consideration, and Mercury's orbit is taken as the starting-point, then, representing the distance from Mercury's orbit to that of Venus by the number 3, the distance of the other planetary orbits from that of Mercury's are roughly in the geometrical progression 6, 12, 24, etc.

This general relationship seems to apply also to the orbits of satellites if distances are measured from that of the first satellite to those of the others. In the table below, the intervals between the orbits of the satellites of Saturn, as derived from the values given in Prof. R. H Baker's "Astronomy", and as given by a geometric series, are compared; and it will be seen from this that there is good reason for the suggestion of the existence of an undiscovered satellite of the planet between the orbits of Iapetus and Phoebe.

I realize, of course, that the measured distances of Titan and Hyperion from Mimas do not correspond with the distances represented in the geometrical series, but I suggest that this may be due to difficulties in determining the actual distances of these satellites from Saturn on account of the relatively high eccentricity of their orbits. With Titan, the major axis at right angles to a terrestrial observer gives an exaggerated maximum elongation upon which the distance would be based; and with Hyperion, the minor axis at right angles gives a relatively smaller maximum elongation. The result is thus to reduce the difference between the two orbits in both directions.

Mean distances between the orbits of	Observed distances in miles	Distances based on geometrical progression
Mimas and Enceladus	32,700	32,700
" " Tethys	67,700	65,400
" " Dione	118,700	130,800
" " Rhea	211,700	261,600
" " Titan	643,700	523,200
" " Hyperion	804,700	1,046,400
" " Iapetus	2,094,700	2,092,800
" " missing satellite	——	4,185,600
" " Phoebe	7,918,700	8,371,200

However this may be, there is a gap of nearly six million miles between the orbits of Iapetus and Phoebe, and the general order of the progression of the other orbits seems to afford evidence of the existence of a new satellite about two million miles from the orbit of Iapetus and four million miles nearer Saturn than Phoebe. It is just possible that

the faint satellite of Saturn, of which Prof. W. H. Pickering reported the discovery in 1905, but which has not since been observed, is the missing body.

J. MILLER.

61A Holborn Viaduct,
London, E.C.1.
Jan. 17.

Methods of Estimating Mental Factors

MR. M. S. BARTLETT has proposed[1] formulæ for the estimation of mental factors as alternatives to formulæ I have given[2]. My formulæ were arrived at by the ordinary regression method. Bartlett's estimates and the regression estimates attain different ends, and it is agreed that each method is correct in the right place. The regression estimates minimize the squares of the discrepancies between the estimates and the true values, summed over the population of persons. Bartlett's estimates minimize the squares of a man's *specific* factors, summed over the tests. If the scores expressed in matrix notation as linear functions of the true factors are

$$Z = MF = M_0F_0 + M_1F_1$$

the two sets of estimates, for the common factors only, are

$$\hat{F}_0 = M_0'(MM')^{-1}Z = M_0'R^{-1}Z \quad \text{(regression estimates)}$$
$$\hat{F}_0 = (M_0'M_1^{-2}M_0)^{-1}M_0'M_1^{-2}Z \quad \text{(Bartlett's estimates).}$$

The regression method has the quality that if factors estimated by it are inserted in the specification equation which defines a vocation in terms of factors, the result is the same as a direct regression estimate of vocational ability from the tests.

If estimates, by either method, of all the factors including specifics are inserted into the specifications MF of the test scores, they reproduce the latter exactly. If, however, only the common factors are estimated and used, Bartlett's reproduce the scores better than the regression estimates do. In such a situation, however, the regression method would again *estimate* the original scores from the estimated common factors, and it is the object of this note to point out that if this is done, the results are identical with those produced by Bartlett's method.

If we estimate the quantities Z from the $\hat{F}_0$ only, by the ordinary methods of regression, we get, bearing in mind that the $\hat{F}_0$ are neither normalized nor uncorrelated,

$$\hat{\hat{Z}} = M_0(M_0'R^{-1}M_0)^{-1}M_0'R^{-1}Z = SZ \text{ say.}$$

Whether we simply insert Bartlett's estimates in M_0F_0, or make a regression estimate of the scores from the $\hat{F}_0$, we reach the result

$$\hat{\hat{Z}} = M_0(M_0'M_1^{-2}M_0)^{-1}M_0'M_1^{-2}Z = EZ \text{ say,}$$

and we see that the matrices S and E are identical if we use the relations

$$R = M_0M_0' + M_1^2$$

and

$$(M_0'R^{-1}M_0)^{-1} = I + (M_0'M_1^{-2}M_0)^{-1}.$$

GODFREY H. THOMSON.

University,
Edinburgh.
Jan. 12.

[1] *Brit. J. Psych.*, **28**, 90 (1937).
[2] (*American*) *J. Educ. Psych.*, **27**, 41 (1936).

Blood Group Inheritance

THE unusual blood group proportions among the Sousseux in French Guinea, found by J. S. de Goldfiem[1] and quoted by R. Elson Dew[2], are inexplicable as a stable distribution on the accepted triple allelomorph theory of blood group inheritance. They are, however, quite consistent with the quadruple allelomorph theory proposed by us[3], if it be assumed that the fourth allelomorph, the AB gene, while rare in most human populations, is the predominant one among the Sousseux. The hypothesis could be tested as follows.

Denoting the four allelomorphic genes R, A, B, D (that is, ab, Ab, aB, AB in our previous notation), let their frequencies be γ, α, β, δ; and let the frequencies of the blood groups O, A, B, AB be r, p, q, s. Then for a stable distribution,

$$\gamma^2 = r, \ \alpha^2 + 2\alpha\gamma = p, \ \beta^2 + 2\beta\gamma = q,$$
$$\delta^2 + 2\alpha\delta + 2\beta\delta + 2\gamma\delta + 2\alpha\beta = s.$$

Hence $\alpha = \sqrt{p+r} - \sqrt{r}$, $\beta = \sqrt{q+r} - \sqrt{r}$,
$\gamma = \sqrt{r}$, $\delta = 1 - \sqrt{p+r} - \sqrt{q+r} + \sqrt{r}$.

(For the triple allelomorph theory, there is the additional equation $\delta = 0$.) The data in question are

$$r = 0{\cdot}01, \ p = 0{\cdot}01, \ q = 0{\cdot}09, \ s = 0{\cdot}89,$$

whence $\gamma = 0{\cdot}100$, $\alpha = 0{\cdot}041$, $\beta = 0{\cdot}216$, $\delta = 0{\cdot}642$.

The gene distribution would therefore be

10 per cent R + 4 per cent A + 22 per cent B + 64 per cent D.

Calculation on this basis gives the following results for the offspring of two parents, one being of group AB (in other cases the usual theory applies).

$AB \times AB = 0{\cdot}75\ (AB) + 0{\cdot}025\ (A + 3AB) + 0{\cdot}20\ (B + 3AB) + 0{\cdot}02\ (O + 3AB) + 0{\cdot}005\ [A + B + 2AB]$,

$A \times AB = 0{\cdot}52\ (AB) + 0{\cdot}26\ (B + 3AB) + 0{\cdot}12\ (O + A + 2AB) + 0{\cdot}085\ [A + AB] + 0{\cdot}015\ [2A + B + AB]$,

$B \times AB = 0{\cdot}49\ (AB) + 0{\cdot}03\ (A + 3AB) + 0{\cdot}07\ (O + B + 2AB) + 0{\cdot}40\ [B + AB] + 0{\cdot}01\ [A + 2B + AB]$,

$O \times AB = 0{\cdot}46\ (AB) + 0{\cdot}06\ (A + AB) + 0{\cdot}31\ (B + AB) + 0{\cdot}15\ (O + AB) + 0{\cdot}02\ [A + B]$.

The notation means that in 75 per cent of families with parents $AB \times AB$ the offspring will be all AB, in 2½ per cent they will be A and AB, expected in the ratio 1 : 3, and so on. On the usual theory, only the family types in square brackets should occur.

It will be seen that the majority of offspring of $O \times AB$ will be either O or AB, that is, anomalies on the usual theory; and a few such anomalies appear in the other three cases. The fourth allelomorph was in fact suggested in order to account for just such anomalies in ordinary populations. Other suggestions which have been made to account for them are *mutation* by various investigators, *crossing-over* by Bauer[4], *trisomy* by Haldane[5]. An examination of blood group pedigrees among the Sousseux would perhaps settle the matter.

J. FOULKES EDWARDS.

Northumberland House,
Green Lanes, London N.4.

I. M. H. ETHERINGTON.

Mathematical Institute,
University of Edinburgh.
Jan. 8.

[1] *C.R. Soc. Biol.*, **123**, 391 (1936).
[2] NATURE, **140**, 1066 (Dec. 18, 1937).
[3] NATURE, **136**, 297 (Aug. 24, 1935); 646 (Oct. 19, 1935).
[4] *Klin. Wochenschr.*, **7**, 1588 (1928).
[5] NATURE, **136**, 432 (Sept. 14, 1935).

Cell Size in Millipedes

THE idea of the constancy of cell size for a particular tissue in different individuals of an animal species has long held sway in zoological literature. This concept has frequently been extended to cover nearly related species[1]. I wish to thank Dr. J. R. Baker, of Oxford, for suggesting this investigation into a case which proved to be at variance with the generally accepted view.

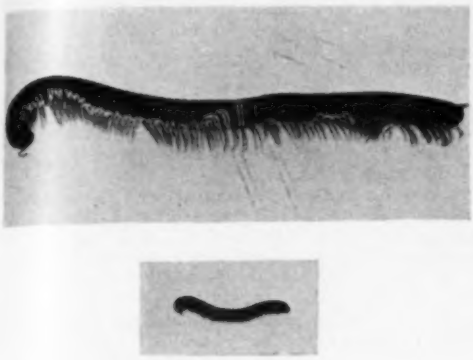


Fig. 1.

ABOVE, *Spirostreptus stenorhynchus*; BELOW, *Cylindroiulus londinensis*. BOTH ABOUT TWO THIRDS NATURAL SIZE.

Spirostreptus stenorhynchus is a very large millipede from Ceylon (Fig. 1). A specimen examined was 13·8 cm. long. The fore-gut (of stomodæal origin) of this animal was fixed in Flemming's fluid with reduced acetic acid content, and transverse sections cut at 5μ. Fat was removed from the sections by immersion in turpentine, and they were afterwards stained in iron hæmatoxylin. These sections were very kindly lent me by Dr. Baker. *Cylindroiulus londinensis*, a British millipede, of average length 2·7 cm., was treated in exactly the same way. It should be noted that these two animals are quite closely related species, both being formerly included in the genus *Iulus*. Flemming's fluid was used since it gives a reasonably good fixation of the nucleus without causing excessive shrinkage in the cytoplasm.

Fig. 2.

FORE-GUT CELLS OF *Spirostreptus* (ABOVE) AND *Cylindroiulus* (BELOW).

In the Ceylon millipede, fifty of the epithelial cells of the fore-gut (see Fig. 2) had an average length of 189 μ, and an average width of 7·8 μ. Corresponding dimensions of the cells of the British millipede were 54 μ and 3·9 μ respectively. It will therefore be seen that the cells of the Ceylon millipede are about fourteen times as large by volume as those of the British millipede. This really enormous difference in cell size (not, however, comparable with the difference in body volume) may perhaps be typical of single-layered epithelia, where symmetry relations according to the size of the lumen would demand larger cells in the larger species.

It may be pointed out, moreover, that W. F. Abercrombie[2] and W. Trager[3], working independently on the larva of the flesh-fly, *Lucilia sericata*, found that the entire growth of the larva from the first instar "is accounted for by increase in size of cells".

The photographs were taken at the John Innes Horticultural Institute by kind permission of Sir Daniel Hall.

H. G. CALLAN.

St. John's College,
Oxford.

[1] See Painter, T. S., *J. Exp. Zoo.*, **50** (1928); also Berrill, N. J. *Phil. Trans.*, B, **225** (1935).
[2] *J. Morph.*, **59** (1936).
[3] *J. Exp. Zoo.*, **71** (1935).

Œstrogenic Activity of Certain Synthetic Compounds

IN earlier communications[1,2] two of us have described the œstrogenic activity of certain derivatives of diphenylethane, and in particular it was shown that the introduction of an ethylene linkage between the α and β carbon-atoms of such compounds greatly increased the potency. A number of stilbene derivatives were found to possess a marked activity. Following up this observation, the activity of *p*-hydroxypropylbenzene was next investigated and compared with that of *p*-hydroxypropenylbenzene (anol). The œstrogenic activity of some specimens of anol was found to be of a very high order, but further research indicated that this remarkable potency was probably due to the presence of a more complex substance produced as a by-product during the demethylation of anethole[3]. Recently, the activity of di-anol has been described[4].

In the meantime an investigation had been initiated at Oxford, the object of which was to prepare possible œstrogenic agents bearing a close structural resemblance to œstrone (or œstradiol) but which should be capable of ready synthesis.

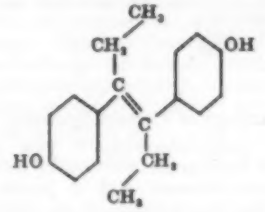
Substance		Dose (mgm.)	Per cent Positive
4-Hydroxy acetophenone		100	Nil
4-Hydroxy propiophenone		10	100
4-Hydroxy butyrophenone		100	100
4 : 4′ : α : β-Tetra hydroxy-α : β-dimethyl-diphenyl ethane		100	100
4 : 4′ : α : β-Tetra hydroxy-α : β-diethyl-diphenyl ethane		0·1 0·01	100 80
4 : 4′ : α : β-Tetra hydroxy-α : β-di-*n*-propyl diphenyl ethane		10	100
4 : 4′-Dihydroxy-α : β-diethyl diphenyl ethane		10	100
Trans-4 : 10-dihydroxy-1 : 2 : 7 : 8 : 13 : 14 :-hexahydro chrysene		1	100
4 : 4′ Dihydroxy-α : β-diethyl stilbene	in sesame oil	0·0005 0·0004 0·00035	100 100 60
	in water	0·0005 0·0003	100 80
	in oil, orally	0·001	80
Diacetate of	in oil	0·001	100

In certain directions, especially in the diphenylethane and stilbene groups, we found it convenient to join forces in order to avoid duplication of work.

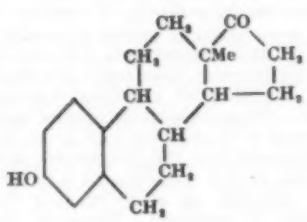
In the preceding table will be found a description of the activity of certain substituted derivatives of 4 : 4′-dihydroxydiphenyl ethane and 4 : 4′-dihydroxystilbene.

It will be noted that by far the most potent substance is 4 : 4′-dihydroxy-αβ-diethylstilbene. This was fully active in ovariectomized rats in a dosage between 0·3 and 0·4 gamma. Comparative tests show it to be between two and three times as potent as œstrone under similar conditions[5]. As can be seen from the table, it is active when dissolved in oil or in aqueous alcohol, or in aqueous solution as the sodium salt. The acetate is also fully active.

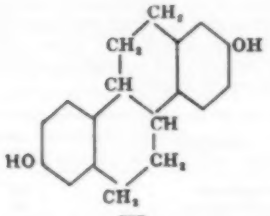
If the formula of this compound, $C_{18}H_{20}O_2$, (I), be written as shown below, the structural resemblance to œstrone, $C_{18}H_{22}O_2$, (II) can be appreciated. It can be seen that it is a possible dimeride of anol.



I



II



III

It is interesting, however, to note that as much as 1 mgm. of dihydroxyhexahydrochrysene (III) is required to produce œstrus in the ovariectomized rat, so that no advantage was gained by the inclusion of the full chrysene structure. The substance had, in fact, an activity of the same order as that of the related 4 : 4′-dihydroxy-αβ-diethyldiphenylethane.

Investigations are in progress upon the pharmacology and biological properties of 4 : 4′-dihydroxy-αβ-diethylstilbene and a series of its acyl derivatives. Other substituents are being introduced at the α and β carbon atoms and the behaviour of the resulting compounds will be reported later.

In view of the fact that 4 : 4′-dihydroxystilbene is the mother substance of a series of œstrogenic agents, we suggest that it may be termed *stilbœstrol*.

The following notes on the preparation of new substances are appended and more detailed publication will follow in another place.

4 : 4′-αβ-*Tetrahydroxy*-αβ-*diethyldiphenylethane* and its *dipropyl analogue* are the pinacols derived from 4-hydroxypropiophenone and 4-hydroxybutyrophenone respectively. The ketones were reduced by means of aluminium amalgam in moist ethereal solution. Crystallized from alcohol, the diethyl compound had m.p. 204–206°; *diacetate*, m.p. 199–200°; the dipropyl compound had m.p. 186–187°, *diacetate*, m.p. 199°.

Trans-4 : 10-*dihydroxy*-1 : 2 : 7 : 8 : 13 : 14-*hexahydrochrysene* (III) crystallized from ethyl acetate, m.p. 263–264°, was obtained by the action of a boiling mixture of hydriodic acid (*d* 1·9) and acetic acid on its dimethyl ether[4].

α-*Ethyldeoxyanisoin*, obtained by the action of alcohol sodium ethoxide and ethyl iodide on deoxyanisoin, is a colourless oil, b.p. 192–193° at 0·65 mm. By reaction with ethyl magnesium bromide it affords 3 : 4-*dianisylhexan*-3-*ol*, colourless plates from alcohol, m.p. 115–117°, and this in its turn yields 4 : 4′-*dimethoxy*-αβ-*diethylstilbene* on dehydration in various ways, for example, by the action of acids, acetic anhydride or phosphorus tribromide. The dimethoxydiethylstilbene crystallizes from light petroleum or alcohol, m.p. 123–124°.

The demethylation by many of the usual methods could not be effected. Thus the action of boiling hydriodic acid furnished 4 : 4′-*dihydroxy*-αβ-*diethyldiphenylethane*, a viscous oil, b.p. 189–190° at 0·8 mm. Aluminium chloride reacts with the stilbene so as to form fission products, phenol and a substituted phenol. Demethylation was found to be best effected by the action of alcoholic potassium hydroxide in a sealed tube at 205° and in this way 4 : 4′-*dihydroxy*-αβ-*diethylstilbene* (diethylstilbœstrol) was obtained; colourless plates, m.p. 167–168° from aqueous alcohol; *diacetate*, prisms, m.p. 123–124°. *Dimethylstilbœstrol*, similarly prepared, has m.p. 193–194° after crystallization from ethylene chloride.

The substances, the names of which are italicized above, have all been submitted to elementary analysis and the results are in agreement with theoretical anticipations.

E. C. DODDS.
Courtauld Institute of Biochemistry, L. GOLDBERG.
Middlesex Hospital, W.1. W. LAWSON.
Dyson Perrins Laboratory, R. ROBINSON.
University, Oxford.

[1] Dodds and Lawson, NATURE, **130**, 627 (1937).
[2] Dodds, Fitzgerald and Lawson, NATURE, **140**, 772 (1937).
[3] Dodds and Lawson, NATURE, **139**, 1068 (1937).
[4] Campbell, Dodds and Lawson, NATURE, **141**, 78 (1938).
[5] Allan, Dickens and Dodds, *J. Physiol.*, **68**, 348 (1930).
[6] Ramage and Robinson, *J. Chem. Soc.*, 610 (1933).

Mechanism of Propagation of Electronic Excitation Energy, and Photosynthesis in Plants

THE main objection to the concept of a 'photosynthetic unit' in the assimilation process of green plants has been that the light quanta absorbed primarily would not sustain the numerous transfers from one chlorophyll molecule to another[1]. Recently, however, a simple mechanism has been suggested[2] whereby electronic excitation energy could be propagated without loss in a complex of dye molecules.

Below, a more complete picture is derived from considerations on the quenching of fluorescence of dyes in solution[3].

In this process an electron of the light absorbing (fluorescent) molecule (D) on being transferred to a higher level (thus constituting the excited form D^*) leaves an empty electronic level behind. If this excited molecule collides with another molecule or ion [acceptor (Acc.)] which possesses an electron, bound with an energy corresponding to this unoccupied level, this electron is transferred to the excited dye, the fluorescence of which is thereby quenched. The molecules in collision constituting a single system, the electron transfer process must be regarded as a quantum mechanical resonance between the states (D^* Acc.) and ($D.^-$ Acc.$^+$) according to the non-adiabatic process[4]

$$D^* + \text{Acc.} \rightleftarrows D^- + \text{Acc.}^+$$

reduced dye (semiquinone).

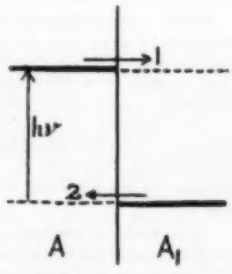
It has been emphasized recently[5] that the double refraction and the probable dichroism of the chloroplasts suggests a regular (crystallic) arrangement of the chlorophyll molecules (Prof. H. Zocher, Prague, has recently been able to prove that the double refraction and dichroism of the chloroplast is partially due to the chlorophyll molecules themselves: private communication) and also strong mutual interaction between the π-electron clouds of the conjugated bond system. A type of such an interaction has been demonstrated in the interesting experiments of Scheibe[5] and Jelley[6] on aggregates of various cyanine dyes. My recent observations that the leucobases of various dyes, for example, methylene blue, Lauth's violet, exert a particularly powerful quenching effect on the fluorescence of the respective dyes show that electronic resonance transfer can easily take place between the excited dye and its leucobase according to

$$D^* + D\text{H}^- \rightleftarrows D^- + D\text{H}, \quad (D^- + \text{H}^+ \rightleftarrows D\text{H})$$

(semiquinone)

If a light quantum is absorbed by an electron of one of the dye molecules in the complex, then on account of the strong coupling forces this electron can travel through the lattice. It then represents an excess electron in each molecule through which it passes, thus converting it into a negative ion for a very short time. But at the same time it leaves a positive charge in the originating molecule, and this positive charge can also travel by the transfer of an electron from a neighbouring molecule.

The diagram represents schematically the propagation of electronic excitation energy. Molecule A absorbs the light quantum ($h\nu$). The excited electron is transferred to a neighbouring molecule A_1 ($\rightarrow$1). The electron deficiency in A is made good by another transfer into its lower level (2 $\leftarrow$). As a result the excitation energy is transferred from A to A_1, and the repetition of these processes propagates the energy through the complex.



It is obvious that there exists a close analogy between the above process and the photo-conductivity and related phenomena in halide crystals, which have been extensively studied by R. W. Pohl and his co-workers[7]. It should therefore be possible to apply the experimental methods of Pohl, in a suitably modified form, to the above problem.

JOSEPH WEISS.

Department of Chemistry,
King's College,
Newcastle-upon-Tyne, 2.
Dec. 21.

[1] Franck, J., and Herzfeld, K. F., *J. Chem. Phys.*, **5**, 237 (1937).
[2] Weiss, J., NATURE, **137**, 997 (1936); *J. Gen. Physiol.*, **20**, 501, (1937).
[3] Weiss, J., NATURE, **136**, 794 (1935). Weiss, J., and Fishgold, H. *Z. phys. Chem.*, B, **32**, 135 (1936). Weiss, J., *Trans. Faraday Soc.*, **32**, 1331 (1936).
[4] cf. London, F., *Z. Phys.*, **74**, 143 (1932).
[5] Scheibe, G., Kandler, L., and Ecker, H., *Naturwiss.*, **25**, 75 (1937); **25**, 474 (1937); Scheibe, G., *Naturwiss.*, **25**, 795 (1937).
[6] Jelley, E. E., NATURE, **138**, 1009 (1936); **139**, 631 (1937).
[7] cf. the latest articles from Prof. Pohl's Institute in Göttingen: Pohl, R. W., *Kolloid Z.*, **71**, 257 (1935); Hilsch, R., *Z. angew. Chem.*, **49**, 69 (1936).

Spontaneous Isomerization of Lycopene

DURING some experiments with benzene extracts of various fruits, it was observed that the calcium hydroxide chromatogram frequently, but not in every case, shows a rather brownish orange layer below the lycopene zone. Subsequent experiments have proved that this behaviour of carefully purified lycopene depends on the time which elapses between the dissolution and the adsorption analysis. A fresh solution forms a uniform chromatogram, but if the liquid has been kept at 20° for 1–2 days, the new polyene ("neo-lycopene") is observed; it then forms a very distinctly separated zone in the chromatogram developed with benzene and light petroleum (3 : 1). The pigment content of this layer reached 3 per cent of the total lycopene in experiments of 24 hours duration; the absorption maxima are 511, 479·5, 450 mμ in benzene and 498·5, 468, 440 mμ in petroleum ether. When the benzene solution is kept at room temperature, neo-lycopene is partly transformed into lycopene (or into a very similar dye which cannot be separated from lycopene in the column).

Gillam and his co-workers[1] have published important and highly interesting observations on the isomerization of carotene, which change, according to their data, takes place in the adsorbent itself, during the chromatographic process. In the case of lycopene, we claim that the chromophor spontaneously undergoes a partial rearrangement in certain solvents, where the ordinary lycopene tends to reach an equilibrium with at least one new compound. The progress of this isomerization is a function of the time, and it has nothing to do with a possible subsequent adsorption. The Tswett column only furnishes a suitable method for showing an effect already present in the solution. The isomerization may also be recognized by spectroscopic and colorimetric readings, independently of the chromatographic technique.

As a close study of the change is disturbed by a gradually increasing tendency to autoxidation and bleaching, the observation that the equilibrium between lycopene and neo-lycopene can be reached far more rapidly at an increased temperature was welcome. Examples: (*a*) A solution of 2·6 mgm. of chromatographically homogeneous lycopene in 25 ml. benzene was boiled under reflux for 20 min., during which time the colorimetric value fell to 2·15 mgm. 'lycopene'; the final chromatogram consisted of two main zones, the relative colorimetric

strengths of which were 100 lycopene to 62 neo-lycopene. Autoxidation did not occur. (*b*) In a similar experiment performed with a pure solution of neo-lycopene, an increase in the colour value was observed during the heating period from 2 mgm. to 2·35 mgm. 'lycopene', and a chromatogram nearly identical with the foregoing was obtained, namely 100 lycopene to 68·5 neo-lycopene. (The presence of a small quantity of iodine does not alter these proportions considerably.)

At present work is in progress in this laboratory to investigate the stability of other carotenoids under the above conditions, including the isomerization of capsanthine, recently described by Zechmeister and Cholnoky[2]. Further, preliminary experiments show that chromatographically homogeneous β-carotene yields in the calcium hydroxide column a second layer (with α-carotene spectrum), if the freshly prepared solution in light petroleum has been previously kept at 70° for 30 min.; however, the spontaneous change of dissolved lycopene suggests that the stability of the conjugated system of natural carotenoids may be far less than is generally accepted.

L. ZECHMEISTER.
P. TUZSON.
University,
Pécs.
Dec. 22.

[1] Gillam and El Ridi, NATURE, **136**, 914 (1935); *Biochem. J.*, **30**, 1735 (1936); Gillam, El Ridi and Kon, *Biochem. J.*, **31**, 1606 (1937).
[2] Zechmeister and Cholnoky, *Liebigs Ann.*, **530**, 291 (1937).

Points from Foregoing Letters

Sir C. V. Raman and B. V. Raghavendra Rao submit Fabry-Perot patterns of light scattered by phenol, showing that, with increasing temperature, Doppler-shifted components come increasingly into evidence. In a non-viscous liquid like toluene, both the displaced and undisplaced components are almost completely polarized with the vibrations vertical. In the more viscous phenol the undisplaced vibration is only partially polarized, appearing both in the vertical and horizontal vibrations. The authors consider that the theory which regards the diffusion of light in liquids as due to the reflection of light by regular and infinitely extended trains of sound-waves present in them, must break down in the case of very viscous liquids.

J. F. Allen and H. Jones report experiments which show that associated with a flow of heat in helium II there is a pressure operative in the reverse direction to the heat flow. Under suitable conditions this pressure is great enough to allow the arrangement to be used as a convenient form of helium pump. A possible explanation of the effect, by regarding heat flow as a flow of disorder, is suggested.

By means of a stigmatic spectral apparatus of high resolving power and brilliancy, Dr. B. Kullenberg has determined the relativistic Stark effect, using the line 4686 A. of ionized helium, and submits a diagram showing how the values found experimentally fit the curves theoretically deduced. He finds that if the field is sufficiently strong (above 18,000 volts./cm.) the measurements are in good agreement with the theory.

A table showing the observed mean distances between the orbits of the known satellites of Saturn is given by J. Miller, who points out that they form a rough geometrical progression—a relation which also exists between the relative distances of the planetary orbits (taking the orbit of Mercury as zero line). From his table, Miller infers the existence of a missing satellite of Saturn, between the known satellites Iapetus and Phœbe, at a mean distance of about four million miles from the orbit of the innermost satellite, Mimas.

Prof. G. H. Thomson discusses the sphere of applicability of his 'regression method' of estimating mental factors and of the alternative formulæ proposed by M. S. Bartlett. If only the common factors, excluding specifics, are estimated and used, then Bartlett's formulæ reproduce the scores better than the regression estimates do, but in such a case the regression method would again estimate the original scores from the estimated common factors and would thus give results identical with those obtained by Bartlett's method.

The blood group proportions of the Soussoux of French Guinea appear to be inconsistent with the accepted theory of blood group inheritance. Dr. J. F. Edwards and Dr. I. M. H. Etherington point out that this could be explained if the inheritance depends on four (instead of three) allelomorphic genes. This view of blood group inheritance was previously proposed on other grounds.

H. G. Callan submits photographs showing the relative size of the Ceylon millipede, *Spirostreptus stenorhynchus* and of the English species, *Cylindroiulus londinensis*, and also photomicrographs showing the relative size of the epithelial cells from the fore-gut. The cells of the Ceylon millipede are about fourteen times as large, by volume, as those of the British species.

A table giving the œstrogenic activity of several compounds bearing a close structural resemblance to the sex hormone œstrone, but capable of being readily synthesized, is submitted by Prof. E. C. Dodds, L. Goldberg, W. Lawson and Prof. R. Robinson, together with brief notes indicating the method of preparation of new compounds. The most potent substance is 4 : 4′-dihydroxy-αβ-diethylstilbene, being between two and three times more active than œstrone. The authors propose the name stilbœstrol for the substance 4 : 4′-dihydroxystilbene, which is the mother substance of a series of œstrogenic agents.

From considerations on the quenching of fluorescence of dyes in solution, Dr. J. Weiss suggests a mechanism for the propagation of electronic excitation energy in a complex of molecules. The author considers that the mechanism might be applicable to the process of assimilation by green plants, the energy of the absorbed light quanta passing from one chlorophyll molecule to another, through the transference of an electron which can travel through the lattice.

Lycopene, a natural colouring matter belonging to the carotenoid series, when adsorbed on calcium hydroxide in a Tswett column, shows sometimes an additional brown band. This, L. Zechmeister and P. Tuzson suggest, is due to isomerization taking place when the solution (in benzene or light petroleum) is kept for a few days. Heating renders the isomerization more rapid, an equilibrium being apparently reached.

Research Items

Cave Paintings of Eastern Spain

PROF. H. OBERMAIER, in a review of the palæolithic art of eastern Spain (*L'Anthropologie*, **47**, 5–6), reconsiders in the light of recent discovery the evidence bearing on its date, which once generally accepted as Pleistocene and Upper Palæolithic, has recently been assigned by certain archæologists to the Mesolithic period. Prof. Obermaier here argues for the Pleistocene dating. The caves with paintings are found in all the Mediterranean provinces extending southwards from Lerida through Tarragona, Teruel, Castellon, Cuenca, Albaceta, Murcia and Jaen. Though mostly maritime, some caves are situated at some distance from the sea in the mountainous interior. Albarracin (Teruel), for example, is 130 kilometres inland. The resemblance with the Franco-Cantabrian cave art of northern Spain, admittedly Pleistocene, is considerable, the most important difference being the prominence of the human form in eastern Spain, rare or absent in the north, and throwing a remarkable light on costume, weapons, etc., as well as on mode of life, warfare, and even belief. Apart from this resemblance, the argument for the age of the eastern paintings must depend upon the character of the animals which are depicted. The fauna of northern Spain is poorer than that of the cave art of France; reindeer, rhinoceros and mammoth are absent. In central, southern and eastern Spain, northern species do not appear at all, while the southern fauna had already disappeared. What remains are the species of general distribution, ibex, deer, horse, Bovidæ, boar, lynx, rabbit. The animal figures of the east are very much reduced in size, but for the most part are clearly to be distinguished, though some on this account are ambiguous in form. Nor were the painters always meticulously careful in detail; nevertheless it has been possible to identify a number of species with certainty, while other identifications are probable. None is domesticated, and all belong to a palæolithic fauna. Two further arguments are adduced: first the resemblance to the *art mobilier* of the cavern of Parpallo, Valencia, from proto-Solutrean and Solutrean levels, and secondly the relation of its schematic forms to the Azilian art in a line of descent in schematization.

Vitamin B_2 and Flavin Phosphoric Acid

A SHORT article in NATURE on December 18, 1937, p. 1070, summarized the present position with regard to the vitamin B_2 complex. It was there mentioned that 'vitamin B_2' is now regarded as a complex of three distinct factors—namely, (1) the pellagra-preventing (P.P.) factor, which cures pellagra in man, monkeys or pigs, and the so-called black-tongue of dogs; (2) lactoflavin (known as 'riboflavin' in the United States), which is needed for the growth and well-being of rats, and probably of many other species; and (3) vitamin B_6 (the so-called 'rat acrodynia', or 'rat pellagra' factor) which prevents certain characteristic skin lesions in rats. Work on the chemical characterization of these three constituents of the 'B_2 complex' has made rapid progress of late. Lactoflavin was already synthesized in the laboratory a year or more ago. In the issue of NATURE referred to, mention was made of the identification of the pellagra-preventing vitamin (or pro-vitamin) with nicotinic acid. The matter is now taken a step further by the recent announcement in the current issue of *Pflüg. Arch. ges. Physiol.*, by Karrer, Laszt and Verzár that vitamin B_6 deficiency in rats is cured by 'flavin phosphoric acid'. The close chemical relationship thus suggested between two constituents of the vitamin B_2 complex, vitamin B_6 and lactoflavin, raises many interesting points which will no doubt be the object of further study.

Pennatulacea of the John Murray Expedition

IN a recent report, Prof. Hickson describes several interesting forms although none is actually new to science (The John Murray Expedition 1933–34. Scientific Reports, **4**, No. 5. The Pennatulacea, by Prof. Sydney J. Hickson, 1937). Numbers of certain species, hitherto only known from a single specimen, are present, providing material for the study of growth and variation, and in one case (*Umbellula huxleyi*) it is possible to prove that several previously described species are only growth stages or varieties of one widely distributed species. *Umbellula huxleyi*, like many others from the deep sea, is now shown to have a very wide geographical distribution, extending perhaps as far east in the Pacific Ocean as Hawaii. The remarkable *Chunella gracillima*, regarded previously as very rare, was found in great numbers in the Pemba Channel, where it was first discovered by the *Valdivia* Expedition. This was associated in both collections with *Funiculina quadrangularis*. The only other locality in which *Chunella gracillima* has been found is in the Bali Sea in the Malay Archipelago, where it is also associated with the only specimen of *Funiculina* obtained during the voyage of the *Siboga*. The sexual condition of all species wherever possible is noted.

Crabs from Singapore

No. 13 of the *Bulletin of the Raffles Museum*, Singapore, Straits Settlements (Aug. 1937), contains many papers of interest, two of which deal with the Brachyura: "Notes on a Collection of Swimming Crabs (Portunidæ) from Singapore" by Chiâ-Jui Shen, and "On the Crabs of the Family Ocypodidæ in the Collection of the Raffles Museum" by M. W. F. Tweedie, curator of the Museum. There are many swimming crabs in this region, but all belong to the sub-family Lupinæ, the groups Lupocycloida and Podophthalmoida each being represented by one species and the group Lupoida by twenty-six. It is shown that the Portunidæ are more abundantly represented in the warmer regions than in the cooler. This paper is illustrated by excellent figures of many of the species, and two new species of *Neptunus* are described. The material for the second paper was collected for the most part mainly in mangrove swamps around Singapore Island and on the east and west coasts of the Malay Peninsula. A key is given of the species (19 and one sub-species) of *Ilyoplax* and their geographical distribution, and there is one new species described. The new genus, *Pseudogelasimus*, closely related to *Ilyoplax*, is proposed for a single male specimen with peculiarly long eyes and associated broadening of the carapace and very unequal chelæ. A large number of other species belonging to other genera are described.

Genitalia of Orthopteroid Insects

No. 5 of vol. 96 of the Smithsonian Miscellaneous Collections (1937) is devoted to a comprehensive account of the male genitalia of orthopteroid insects, written by Mr. R. E. Snodgrass of the U.S. Bureau of Entomology. The author points out that the external genitalia in these insects are primarily phallic organs. Accessory parts or periphallic (clasping) organs are but little developed and when present they are, for the most part, secondary formations having no apparent relationship in the different groups. The true appendages of the ninth segment are, however, retained in many families as a pair of small styli which are carried on the hind margin of the 9th sternum. It is only in the Grylloblattidæ that these styli retain their bases or coxopodites (coxites): in all other families these basal elements are fused with the sternum. The median penis of Ephemeroptera and some Dermaptera is a different structure from that of the Orthoptera because it is clearly a product of the union of two separate penes, each containing an outlet duct. The median penis of Orthoptera, and probably of most pterygote insects, is not produced by the union of two primary organs, each containing part of a primitive lateral duct. The external and internal genitalia, and their homologies, are discussed in great detail in all the Orthopteroid orders and related groups. Mr. Snodgrass's account is accompanied by numerous original figures notable for their clarity and detail. At the end of the memoir there is a very full bibliography of the literature on the subjects concerned.

Photosynthesis of Coffee Leaves under Natural Conditions

F. J. NUTMAN has recently described a method of studying the carbon dioxide absorption by individual leaves under field conditions (*Ann. Bot.*, N.S., **50**, July 1937), and by the use of this method supplies evidence that these leaves assimilate more vigorously in shade than in full sunlight under tropical conditions in the northern province of Tanganyika Territory. The reasons for this behaviour are discussed; it is concluded that stomatal closure in direct sunlight is the most probable explanation and experimental evidence in support of this conclusion is promised in a subsequent communication. These conclusions have some general importance as Nutman has previously shown that the cause of a serious die-back disease of coffee in East Africa may be found in a shortage of carbohydrates.

'Brown Oak' Disease

MR. K. T. ST. G. CARTWRIGHT has investigated the cause of a brown rot of oak and sweet chestnut (*Trans. Brit. Mycol. Soc.*, **21**, Pts. 1 and 2, 68, Oct. 1937). The common beef-steak fungus, *Fistulina hepatica*, is responsible, and though it may cause little loss of strength in the early stages, a severe attack makes the wood very brittle. The decay does not continue in converted timber, and 'brown oak' is actually easier for the carpenter's work than normal wood. Growth of the fungus is most rapid at 25°–27° C., and the paper suggests that it may obtain its sugar from the breakdown of tannin; the brown material may be a degradation product of lignin and hemicelluloses. Full descriptions of the organism as it appears in wood and upon culture media are given, and two coloured plates aid in realistic portrayal.

Mounds of Arctic America

ALL travellers on the low coastal plain of northern Alaska between Point Barrow and the Mackenzie delta have noted the curious, isolated, more or less conical mounds that diversify the otherwise featureless plain. The Eskimos call such a mound a *pingo*. In a paper in the *Geographical Review* of January 1938, Mr. A. E. Porsild discusses the origin of these and other earth mounds in north-western America and Greenland. He agrees with E. de K. Leffingwell that the Alaskan mounds may be formed by hydraulic pressure. This type is old and shows no sign of recent movement. The freezing of the surface layers over previous unfrozen strata produced conditions favourable to artesian wells. Where downward freezing checked the subterranean seaward flow of water, hydraulic pressure forced upwards the surface layers. A second type of mound, common in the Mackenzie delta, is found in level country or near the border of a lake or former lake basin. This type ranges from a few feet to more than two hundred feet in height and averages 40–75 ft. They often show a median rupture sometimes enlarged to a 'crater' and a well-defined stratification conforming to the slope of the surface. Mr. Porsild suggests that these mounds are formed by local upheaval, due to expansion following downward freezing of a body of water enclosed between bed rock and frozen surface soil. The position of this type of mound supports the theory. When sedimentation fills a lake, freezing of the surface is sure to occur first, thus producing the necessary conditions for the subsequent elevation of the mound. Many of the mounds are in an advanced stage of destruction due to subaerial erosion: some contain small lakes.

Earthquakes of the Channel Islands

SEVEN years ago, Mr. A. E. Mourant issued a valuable catalogue of the earthquakes of the Channel Islands from 842 until 1931 (Société Jessiaise, 50 pp.). To this, he has recently added a supplement (*Trans. Soc. Guern.*, **12**, 523–540; 1937) containing accounts of nineteen additional earthquakes from 1640 until 1935, the majority of which originated in centres near the Channel Islands. Of these centres, the one most frequently in action (especially in 1804, 1843 and 1926) is the Jersey focus, situated off the Cotentin coast opposite Jersey. Another important focus, connected with strong earthquakes in 1799 and 1843, lies beneath or near Guernsey. Mr. Mourant notices the interesting point that the occurrence of an earthquake in the Channel Islands tends to be associated with the approach of a depression after an interval of fine weather.

Trade and Counter-trade Winds

MANY interesting facts about the trade and counter-trade winds are revealed in a detailed analysis of eleven years of observations with pilot balloons at Kingston, Jamaica, that is given by S. Proud in Professional Note No. 78 of the Meteorological Office. The natural wind structure above the locally controlled surface wind consists of a layer of trade winds (which blow mainly from east and south-east) several kilometres thick, surmounted by a more shallow transitional layer of veering wind that leads to the counter-trade, which last is an extension southwards and upwards into the tropics of the westerlies of temperate latitudes. The gradient

of temperature between the poles and the equator in the stratosphere, which is the reverse of that at the earth's surface, is such as to weaken and ultimately to reverse the westerlies at great heights above the tropopause. Such reversals were found on three occasions, one during the remarkable ascent to 26 km. (87,000 feet) of October 6, 1928, which showed south-easterly winds from 20 to 26 km. Apart from day to day variations in the wind structure, which are considerable, there is the well-marked annual oscillation from south to north and back again of the northern boundary of the trade winds at the surface in accordance with the varying declination of the sun but with a lag of about two months, which tends to cause a similar variation in the height at which the counter-trade is reached, this being much less in and around March than in September. The completeness of the reversal is, however, much greater from November until May than in other months. It is shown that the few occasions when the trade wind was absent at all heights were mostly when the main polar front was in the neighbourhood or when a hurricane was developing, generally to the north of Jamaica.

Photochemical Union of Hydrogen and Chlorine

A. J. Allmand, H. C. Craggs and G. V. V. Squire (*J. Chem. Soc.*, 1869; 1937) have carried out investigations on the above subject. In reactions at low pressures in the absence of oxygen the effect of light intensity (I) on the velocity was found to be proportional to I^n, where n varied over the range $0{\cdot}05 - 1$, the latter figure being found at low chlorine pressures, the values becoming lower as the light intensity and chlorine pressure were increased. At sufficiently high pressures, there was an intensity range in which $n = 0{\cdot}5$. The rate of reaction and quantum yield passed through a maximum as the chlorine pressure was increased. Intensive drying of a low-pressure mixture was not found to inhibit the reaction in light, the addition of small quantities of water vapour to the dried gases actually retarding the reaction somewhat. The results are explained by assuming the existence of the radical Cl_3. Reaction chains are terminated by disappearance of Cl and Cl_3 both on the walls and, without triple collisions, in the gas phase.

Solubilities of Citric and Tartaric Acids

SINCE the information on the solubilities of citric and tartaric acids in water was very incomplete, these properties have been reinvestigated by L. H. Dalman (*J. Amer. Chem. Soc.*, **59**, 2547; 1937) who gives values from 0° to 100° for both acids. The solubility curve for tartaric acid is a straight line representing solutions in equilibrium with anhydrous tartaric acid, this line being represented by the equation $s = 51{\cdot}8573 + 0{\cdot}2643\,t$, where s is solubility in per cent by weight and t is temperature. The solubility curve for citric acid consists of two straight lines which intersect at 35·8°; below this temperature, citric acid monohydrate exists, whilst above it, anhydrous citric acid is the stable phase. The solubility curve for the monohydrate is represented by the equation $s = 48{\cdot}9559 + 0{\cdot}5231\,t$, and that for the anhydrous acid by $s = 57{\cdot}8564 + 0{\cdot}2616\,t$.

Improvements in Cinema Sound Reproduction

THE improvements in the quality of the sound reproduction in the cinemas of Great Britain has greatly increased since its inception ten years ago. In the chairman's address to the Radio Section of the Institution of Electrical Engineers given on November 3, these developments are broadly traced out and an indication is given of the trends of further research. The average human ear, it was stated, can appreciate sounds having frequencies lying between 16 and 20,000 cycles per second. The early equipments of 1928–30 had a frequency range lying between 100 to 4,000 C.P.S. and a power range of 30 'decibels'. At 1,000 C.P.S. a power range of 130 decibels can be appreciated lying between the threshold of audibility and maximum audibility. The difficulties of maintaining a recording power range of 30 decibels on the film led to serious alterations in the character of the recorded sound. Distortion was also introduced by the film propelling mechanism, which consisted of a gear-wheel and sprocket-tooth. A harsh and throaty reproduction was thus produced. The volume range of the film is expressed as the ratio of the amplitude of the maximum signal that can be recorded on the track to the amplitude of the background noise from the film itself. If the background level is 30 decibels below the maximum signal it is inaudible. The elimination of ground noise was the aim of the earlier inventors, and this led to considerable improvements. The extension of the frequency range of the amplifiers has been from 100–4,000 to 50–8,000. The loud speaker range has been extended to 30–8,000 and the harmonic distortion has been greatly reduced. The amplifiers and loudspeakers are now in an advanced state of development. Cinema acoustics are becoming better understood, but it is not yet possible to predict with confidence the overall characteristics of a well-tried equipment when installed in a new auditorium.

Comparison of Right Ascensions

W. W. H. GREAVES has recently issued a paper "A Comparison between the Right Ascensions of the Second Greenwich Catalogue of Stars for 1925·0 and of the FK3" (*Mon. Not. Roy. Astro. Soc.*, **98**, 1, Nov. 1937). The systematic differences in right ascension between the Second Greenwich Catalogue for 1925·0 and the *Dritter Fundamentalkatalog des Berliner Astronomischen Jahrbuchs* (usually referred to as "FK3"), have been determined, and this complete systematic difference $\Delta\alpha$ is given by $\Delta\alpha = \Delta\alpha_\alpha + \Delta\alpha_\delta$, the terms on the right-hand side being taken from tables. It has been found that the $\Delta\alpha_\alpha$ values include periodic terms which involve the tangent of the declination, and it is suggested that this may be attributed to a periodic error in the determination of the azimuth of the Airy transit circle. In the previous Greenwich Catalogue, a similar effect was noticed, but opposite in phase. This change appears to be associated with a change in the system of determining azimuth. For the first catalogue, the azimuths were based on the observations of nine stars situated within 4° of the north pole, but when the second catalogue was commenced in 1922, the azimuth list was extended down to declination + 45°, and at present comprises 79 stars. This appears to have introduced a noticeable change in the periodic azimuthal term, but it is admitted that the precise instrumental origin of the change is obscure. It is suggested that a diurnal oscillation in azimuth with a seasonal change in its amplitude might be a possible contributory cause.

A Simplification of Maxwell's Equations in Conformity with the Flux-cutting Principle

By Dr. C. V. Drysdale, C.B., O.B.E.

DURING the last thirty years, the question as to whether electromagnetic induction is caused by the change or by the cutting of magnetic flux has been debated at intervals. Faraday's rotating disk experiment and the later experiments of Blondel[1] and of Messrs. Cramp and Norgrove[2], as well as Prof. H. A. Wilson's experiments with moving dielectrics[3], all appear definitely to favour the flux-cutting hypothesis; and Rowland's experiments with revolving electrostatically charged disks[4] indicated that a magnetic force is similarly induced by the cutting of an electric field. There seems little doubt that Faraday himself believed that electromagnetic induction was produced by the cutting of his magnetic "lines".

The four fundamental equations of Maxwell for a non-conducting dielectric medium:

$$\text{(i)}\ 4\pi D = \varepsilon E, \qquad \text{(iii)}\ -\operatorname{curl} E = \dot{B},$$
$$\text{(ii)}\ B = \mu H, \qquad \text{(iv)}\ \operatorname{curl} H = 4\pi \dot{D},$$

(where E and H are the electric and magnetic forces, D and B the corresponding displacement and induction; and ε and μ the dielectric constant and permeability of the medium, respectively) were avowedly intended to put Faraday's concepts into mathematical form; but the two latter equations are obviously based on the change of flux principle, as they give the line integrals of the electric or magnetic forces around unit area due to the rate of change of magnetic or electric flux through that area, and not the actual forces themselves. These two equations are not only difficult to comprehend and to visualize physically, but also they are difficult of application owing to the complex differential equations to which they give rise; and, if the flux-cutting principle is the true one, they are not completely fundamental.

It is easy to show that a simple transformation of the Maxwellian equations divests them of all complexity and harmonizes them with the flux-cutting principle. For if we write $j\frac{\partial}{\partial x}$ for curl, equation (iii) becomes

$$-j\frac{\partial E}{\partial x} = \frac{\partial B}{\partial t} = \frac{\partial B}{\partial x}\frac{dx}{dt} = V\frac{\partial B}{\partial x},$$

from which $E = jVB$, if $E = 0$ when $V = 0$. This is equivalent to the dynamo designer's formula E.M.F. $= lVB$ for the electromotive force in a conductor of length l moving transversely with velocity V across a magnetic field B, since the electric force E is the electromotive force per unit length. The quadrantal versor $j = \sqrt{-1}$ simply implies that the electric force is perpendicular to the plane containing the motion and magnetic flux, and does not affect its magnitude.

Similar treatment of equation (iv) gives us $H = -j4\pi VD$, which is obviously proportional to the rate of cutting the electrostatic flux and is in accordance with the results of Rowland's experiments; and if we harmonize the electrostatic and magnetic units by writing J for $4\pi D$, which implies 4π electrostatic "lines" of induction per unit charge, in conformity with 4π magnetic lines per unit pole, Maxwell's equations become:

$$\text{(i)}\ J = \varepsilon E, \qquad \text{(iii)}\ E = jVB,$$
$$\text{(ii)}\ B = \mu H, \qquad \text{(iv)}\ H = -jVJ,$$

for an isotropic dielectric medium moving with velocity V, or:

$$\text{(ia)}\ J = \varepsilon E, \qquad \text{(iiia)}\ E = -jVB,$$
$$\text{(iia)}\ B = \mu H, \qquad \text{(iva)}\ H = jVJ,$$

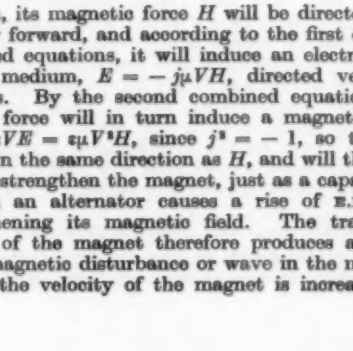
for a stationary isotropic dielectric and moving fields. The change of sign in the last two equations is equivalent to the change from the 'right hand' to the 'left hand' rule in changing from moving armature to moving field machines.

These equations are all of the same simple linear form, and are easily grasped, memorized and handled, since the last two may be summed up as:

Induced $\left\{\begin{matrix}\text{electric}\\\text{magnetic}\end{matrix}\right\}$ force is equal to the rate of cutting $\left\{\begin{matrix}\text{magnetic}\\\text{electric}\end{matrix}\right\}$ lines.

Applications to Electromagnetic Wave Propagation

A few applications to the theory of electromagnetic wave propagation will serve to show their convenience. Combining (iia) and (iiia), we have $E = -j\mu VH$; and combining (ia) and (iva), $H = j\varepsilon VE$. If we suppose the north pole of a magnet moving transversely through an isotropic non-conducting medium with velocity V, as shown in the accompanying



diagram, its magnetic force H will be directed horizontally forward, and according to the first of these combined equations, it will induce an electric force in the medium, $E = -j\mu VH$, directed vertically upwards. By the second combined equation, this electric force will in turn induce a magnetic force $H^1 = j\varepsilon VE = \varepsilon\mu V^2 H$, since $j^2 = -1$, so that H^1 will be in the same direction as H, and will therefore tend to strengthen the magnet, just as a capacitance load on an alternator causes a rise of E.M.F. by strengthening its magnetic field. The transverse motion of the magnet therefore produces a forced electromagnetic disturbance or wave in the medium, and as the velocity of the magnet is increased the

magnetic and electric fields will increase, unless H is diminished to $H - H^1 = (1 - \varepsilon\mu V^2)H$, as an engineer reduces the excitation of an alternator to prevent the rise of voltage with a leading current. When $\varepsilon\mu V^2 = 1$, or $V = 1/\sqrt{\varepsilon\mu}$, therefore, H should be reduced to zero, or the magnet may be withdrawn, and the forced electromagnetic wave will persist as a free one in which E and H are maintained by their reciprocal inductive interactions, and it will travel forward unchanged with the velocity $V = 1/\sqrt{\varepsilon\mu}$, which is Maxwell's expression for the velocity of propagation of electromagnetic waves, including light. Since $E = -j\mu VH$, and $V = 1/\sqrt{\varepsilon\mu}$, $E = -j\sqrt{\mu/\varepsilon}\,.\,H$: so that as ε and μ are constants for all dielectric media, E and H must have a constant ratio and hence have the same wave-form and phase.

The formula $E = -jVB = -j\mu VH$, which represents the rate of cutting magnetic lines, is already familiar to scientific and technical students, but the corresponding formula $H = jVJ = j\varepsilon VE$, which represents the rate of cutting electric lines, is not; so that it may be well to show that it is in conformity with known elementary principles. A vertical electric force E in a dielectric medium produces an upward electrical displacement D such that $4\pi D = \varepsilon E$, so that if we consider the magnetic field H as stationary while the medium is flowing past it with velocity V in the opposite sense, the effect of this displacement will be that of two horizontal surfaces, an upper one charged with surface density $+D$, and a lower one charged with density $-D$, both moving with the medium from right to left. The upper surface will be equivalent to a current sheet of intensity VD per unit breadth flowing from right to left, and the lower to a similar current sheet flowing in the opposite sense since it is negatively charged; so that the total effect will be that of a current sheet or solenoid of intensity VD per unit length circulating round the region of electric displacement in a counter-clockwise direction, which must produce a magnetic force H in that region equal to $4\pi VD = \varepsilon VE$ and directed horizontally forward, and hence $H = -j\varepsilon VE = -jVJ$, the negative sign being due to our dealing in this case with a moving medium instead of moving fields. Since for a moving medium $E = jVB = j\mu VH = \varepsilon\mu V^2E$, E and H will be mutually maintained when the velocity of the medium $V = 1/\sqrt{\varepsilon\mu}$, so that if an electromagnetic disturbance is once started, it will persist unchanged in magnitude and position and will therefore be travelling with the velocity $1/\sqrt{\varepsilon\mu}$ relatively to the moving medium. This is analogous to Prof. P. G. Tait's well-known simple demonstration of the propagation of transverse waves along stretched cords or belts.

Crystalline Media. The above equations apply for all isotropic non-conducting dielectrics, but in crystalline media ε varies with the orientation of E, so that the direction of D or J is not in general identical with that of E or perpendicular to the plane of B and V; and as it is only the component of J perpendicular to V which is concerned in the cutting and the induction of H, we must write $H = jVJ \sin\theta$, or $[VJ]$, where θ is the angle between J and V, and the square brackets imply the vector product of V and J. Similarly we may write $E = -[VB]$, but since the permeability of dielectric media does not differ materially in any direction from that of space, B is simply μH and is always in the direction of H and perpendicular to V, so that we may write $E = -jVB$ or $-[VB]$ as we prefer. Hence the fundamental equations for all dielectric media are:

$J_1 = \varepsilon_1 E_1$ etc., $B = \mu H$, $E = -[VB]$, and $H = [VJ]$, which lead to the following six simple algebraical equations:

$$\begin{aligned}
E_1 &= V_3B_2 - V_2B_3 = \mu(V_3H_2 - V_2H_3)\\
E_2 &= V_1B_3 - V_3B_1 = \mu(V_1H_3 - V_3H_1)\\
E_3 &= V_2B_1 - V_1B_2 = \mu(V_2H_1 - V_1H_2)\\
H_1 &= V_3J_2 - V_2J_3 = \varepsilon_3V_3E_2 - \varepsilon_2V_2E_3\\
H_2 &= V_2J_1 - V_1J_3 = \varepsilon_1V_3E_1 - \varepsilon_3V_1E_3\\
H_3 &= V_1J_2 - V_2J_1 = \varepsilon_2V_1E_2 - \varepsilon_1V_2E_1
\end{aligned}$$

where the suffixes imply the components in the three axes of the crystal.

Combining these we have:

$$\begin{aligned}
\{1 - \varepsilon_1\mu(V_2^2 + V_3^2)\}E_1 + \varepsilon_2\mu V_1V_2E_2 + \varepsilon_3\mu V_1V_3E_3 &= 0\\
\{1 - \varepsilon_2\mu(V_1^2 + V_3^2)\}E_2 + \varepsilon_3\mu V_2V_3E_3 + \varepsilon_1\mu V_1V_2E_1 &= 0\\
\{1 - \varepsilon_3\mu(V_1^2 + V_2^2)\}E_3 + \varepsilon_1\mu V_1V_3E_1 + \varepsilon_2\mu V_2V_3E_2 &= 0
\end{aligned}$$

Hence if the propagation is along axis 1, $E = 0$, $(1 - \varepsilon_2\mu V_1^2)E_2 = 0$, and $(1 - \varepsilon_3\mu V_1^2)E_3 = 0$, which show that the components E_2 and E_3 travel with the velocities $1/\sqrt{\varepsilon_2\mu}$ and $1/\sqrt{\varepsilon_3\mu}$ respectively, so that they must be regarded as separate waves polarized in perpendicular planes. Similarly for propagation along axes 2 and 3, and hence the wave surface must have two sheets intersecting the three axes at radii a and b, a and c, and b and c respectively, where $a = 1/\sqrt{\varepsilon_1\mu}$, $b = 1/\sqrt{\varepsilon_2\mu}$, and $c = 1/\sqrt{\varepsilon_3\mu}$.

It should be noted that since the directions of J and E are not in general the same, the wave cannot be self-maintained unless E, J and V are coplanar, as if J is deviated out of the plane EV, $H = [VJ]$ must be perpendicular to the plane JV and the induced electric force $E_1 = -\mu[VH]$ will be in the plane JV instead of the plane EV and cannot be coincident with E for any value of V. But for any direction of E there will be a plane containing E and J, so that if V is in this plane and perpendicular to E, the induced electric force will be identical with E for a certain value of V, and hence a plane polarized beam can be transmitted in that plane. For E, J and V to be coplanar the scalar product $(EJV) = (\varepsilon_3 - \varepsilon_2)E_2E_3V_1 + (\varepsilon_1 - \varepsilon_3)E_1E_3V_2 + (\varepsilon_2 - \varepsilon_1)E_1E_2V_3$ must be zero, and it is easy to show that this condition can always be satisfied for two perpendicular planes. Hence for any direction of propagation the electric force will be resolved into two perpendicular components both of which will be self-maintaining or transmitted, but in general with different velocities, so that the medium will be doubly refracting and the two components will be plane polarized in perpendicular planes.

Semi-Conducting Dielectrics. In such media an electric force E produces a steady current of density $D = J/4\pi = gE$, where g is the conductivity, in addition to $J = \varepsilon E$, and hence $J = \varepsilon E + 4\pi gE$, where $E = \int E dt$. Hence for all isopic semi-conducting media:

$$J = \varepsilon E + 4\pi gE,\ B = \mu H,\ E = -jVB, \text{ and } H = jVJ,$$

and the induced electric force $E^1 = \mu V^2(\varepsilon E + 4\pi gE)$, which must balance the impressed electric force E for a self-maintained wave. But the power dissipated in the conductance causes an attenuation or reduction of E as the wave travels forward, and since the displacement of the dissociated ions depends on the previous variations of the electric force, we shall only

obtain the steady periodic condition by differentiating twice with respect to time, and writing $\frac{d^2E^1}{dt^2} = \mu V^2(\varepsilon\ddot{E} + 4\pi g\dot{E})$. The variations on the right-hand side depend simply upon the changes of E with time, irrespective of the motion of the wave in space, but the induced electric force E^1 is caused by the cutting due to the motion and we must therefore write

$$\frac{dE^1}{dt} = \frac{\partial E^1}{\partial x}\frac{dx}{dt} = V\frac{\partial E^1}{\partial x}, \text{ and } \frac{d^2E^1}{dt^2} = V^2\frac{\partial^2 E^1}{\partial t^2},$$

which gives us $\frac{\partial^2 E}{\partial x^2} = \varepsilon\mu\frac{\partial^2 E}{\partial t^2} + 4\pi g\mu\frac{\partial E}{\partial t}$ for a self-maintained wave.

This relation arises directly from the Maxwellian equations, but the above treatment is not only more simple but also gives a clear idea of the physical processes involved, and it directs attention to the question of the actual displacement of the dissociated ions which may give rise to transients.

Lorentz Theory of Moving Media. According to the ionic constitution of matter, the absolute dielectric constant of a medium is $\varepsilon_0 + \varepsilon_i$, where ε_0 is the absolute dielectric constant of space, and ε_i that due to the displacement of the ions, which is equal to $4\pi\Sigma\frac{Ne^2}{K - m\omega^2 + jb\omega}$, where N is the number of ions of charge e, mass m, coupling constant k, and damping coefficient b per unit volume, for a sinusoidal disturbance for which ω is 2π times the frequency; and this in conjunction with the above equations leads to Drude's theory of dispersion. But if the medium is moving and carrying the ions along with it with a velocity v in the direction of propagation, an electromagnetic disturbance travelling with velocity V only travels with velocity $V - v$ relatively to the ions. The conditions are therefore similar to those in an induction motor in which the revolving field cuts the stationary stator bars with a velocity V and the revolving rotor bars with velocity $V - v$, the former being represented by the stationary ether between the ions, and the latter by the moving ions. If a magnetic field H is moving with velocity V through the medium, it will induce an electric force $E_0 = -j\mu VH$ acting on the stationary ether, and $E_i = -j\mu(V - v)H$ acting on the ions; and hence $J_0 = -j\varepsilon_0\mu VH$, and $J_i = -j\varepsilon_i\mu(V - v)H$. These electric inductions will in turn induce magnetic forces $H_0 = jVJ_0 = \varepsilon_0\mu V^2H$ in the ether and $H_i = \varepsilon_i\mu(V - v)^2H$ due to the ions, so that the total induced magnetic force will be $H^1 = H_0 + H_i = \mu\{\varepsilon_0V^2 + \varepsilon_i(V - v)^2\}H$, and the wave will be self-maintaining if $H^1 = H$, or $\varepsilon_0\mu\{V^2 + \frac{\varepsilon_i}{\varepsilon_0}(V - v)^2\} = 1$.

But $\frac{\varepsilon_0 + \varepsilon_i}{\varepsilon_0} = 1 + \frac{\varepsilon_i}{\varepsilon_0}$ is the ordinary relative or measured dielectric constant of the medium $\varepsilon = n^2$, where n is the refractive index of the medium for the frequency of the disturbance, and hence $\varepsilon_i/\varepsilon_0 = n^2 - 1$ and $V^2 + (n^2 - 1)(V - v)^2 = 1/(\varepsilon_0\mu) = c^2$, where c is the velocity of propagation in space.

To the first order of $v/V = nv/c$, this gives us:

$$V = \frac{c}{n} + \frac{n^2 - 1}{n^2}v,$$

if the source is moving with the medium, or

$$V = \frac{c}{n} + \left(\frac{n^2 - 1}{n^2} - \frac{\lambda}{n}\frac{\partial n}{\partial\lambda}\right)v$$

for a stationary source and moving medium.

These are Lorentz's relations for the propagation of electromagnetic waves through moving dispersive media, which have been confirmed by the moving-water experiments of Zeeman and give a theoretical basis for the Fresnel drag coefficient $(n^2 - 1)/n^2$.

The above applications will suffice to show that these simple equations lead to results which are in agreement with those derived from the Maxwellian equations, and their simplicity and fundamental correctness of principle may lead to useful extensions, especially as they focus attention on the physical interactions involved. For closed circuits of rigid conformation where we are concerned only with the total induced electromotive force, the ordinary rate-of-change or 'transformer' formula $E = -\partial N/\partial t$ is correct and more convenient, and even for deformable circuits I have shown[4] from energy considerations that the most convenient general formulæ for calculating the force or torque in such systems are $f = \frac{1}{2}i^2\frac{\partial L}{\partial x}$ or $T = \frac{1}{2}i^2\frac{\partial L}{\partial\theta}$, where f is the force, T the torque, and L the inductance of the circuit; but it seems to be proved beyond doubt that electric and magnetic forces can only be induced by the cutting of magnetic or electrostatic fields, so that even in closed circuits it appears that any change of flux must involve the actual cutting of magnetic or electrostatic "lines", although it may be difficult to visualize the process in many cases. The simplified Maxwellian equations, based on the flux-cutting or 'dynamo' principle, appear to be the fundamentally correct ones; and, as they are much more simple to handle and comprehend in dealing with radiation problems, it would seem that they should be adopted.

Summary

Faraday's rotating disk experiment and the later experiments of Blondel, Cramp and Norgrove, and H. A. Wilson all indicate that magneto-electric induction is caused by the cutting of a magnetic field rather than by its rate of change; and Rowland's experiments with rotating electrostatically charged disks similarly indicate that a magnetic force is induced by the cutting of an electrostatic field. The fundamental Maxwellian equations are based on the change of flux principle, but it is here shown that a simple transformation of these equations brings them into harmony with the flux-cutting principle and reduces them to four simple algebraic or vector equations which enable radiation problems to be treated with great simplicity and easy grasp of the physical processes involved. Application of these equations to the propagation of electromagnetic waves in isotropic and crystalline dielectrics and in semi-conducting and moving media show that they lead to the same results as the Maxwellian equations.

Comptes rendus, **159**, 674–679 (1914). *Electrician*, **75**, 341 (1915).
[2] *J. Inst. Elect. Eng.*, **78**, No. 472, 481 (April 1936).
[3] *Phil. Trans. Roy. Soc.*, A, **204**, 121 (1905).
[4] *Phil. Mag.*, (v), **27**, No. 169 (June 1889).
[5] *J. Sci. Instruments*, **9**, 209–216 (1932). *J. Inst. Elect. Eng.*, 72 365–384 (1933).

Food of the Herring*

TWO researches on food of adult herring have recently been published. It is interesting to compare the results, although Savage's work covers March–October only, chiefly May–August, and Jespersen's was continued throughout the year. The period covered is the same, from 1931 until 1934 and 1935. In 1931 the herring fishery at Bornholm was very poor in both number and size of fish and it was found that those feeding were remarkably few in number, a fact probably correlated with the scarcity of food, especially copepods. Off Shields and in the northern North Sea, however, the year 1931 was a rich feeding year, due almost entirely to the abundance of *Calanus*. Although *Calanus* is such an important herring food in many regions it is not present at Bornholm (the low salinity accounting for its absence), the chief copepods being *Pseudocalanus elongatus*, eaten during the first half of the year, and *Temora longicornis* and *Eurytemora hirundoides* (taken together), on the whole even more important, eaten throughout the year, but especially in the winter half.

Copepods form the main food of the herring in both districts. There is little feeding during the great East Anglian autumn fishery and in the Bornholm herrings it is lowest in August-October, in and just after the spawning season. In both districts it is highest in spring and early summer and the main food consists of copepods, but *Oikopleura* occupies an important position in some years as food in the North Sea and is not present at all in Bornholm. *Ammodytes*, however, was frequently eaten both at Bornholm and off Shields although absent from farther north. Whereas, however, it is eaten chiefly in winter and early spring at Bornholm it seems to be eaten indiscriminately at other times of year at Shields. In fact, there is a more marked difference in the seasonal food at Bornholm than in the North Sea with the exception of the all-important *Calanus*, the maximum of which is in all years in May.

In the Bornholm herring in spring the food is principally copepods and young fish, in summer principally copepods and cladocerans, in autumn copepods and in some degree cladocerans, in winter, besides copepods, chiefly larger crustaceans. In the North Sea the principal food, varying in different years, is *Calanus* in spring and summer, *Temora longicornis* in late summer, *Oikopleura* usually in spring and early summer, whilst other copepods, cladocerans and larger organisms, such as *Sagitta*, Crustacea and *Ammodytes* occur at different times, varying in different years. The curve shows a maximum of food, due to *Calanus*, in May, and a characteristic smaller secondary peak at the end of August and beginning of September due to decapod larvæ, *Oikopleura*, *Sagitta*, Schizopods, *Limacina* or Amphipods, *Temora* and, occasionally, *Calanus*.

Calanus was the principal item in the food of the Shields herring and the date and size of its maximum in the plankton appeared to have a close relation with the appearance and size of the shoals, an early maximum being associated with abundant herring and a late maximum with poor catches.

It is an interesting fact that the 1931 year-class of herring, that is to say those fish spawned after the rich feeding of that year, has been a very poor one since it entered the shoals as three-year-old fish in 1934; on the other hand, the fish spawned after the poor feeding of 1932 have proved to be a very rich year class.

* Meddelelser fra Kommissionen for Danmarks Fiskeriog Havundersøgelser. Serie Plankton, Bind 3, Nr. 2: The Food of the Herring in the Waters round Bornholm. By P. Jespersen. Pp. 40. (København: C. A. Reitzels Forlag, 1936.) 2.40 kr. Ministry of Agriculture and Fisheries. Fishery Investigations, Series 2, Vol. 15, No. 5: The Food of the North Sea Herring, 1930-1934. By R. E. Savage. Pp. 60. (London: H.M. Stationery Office, 1937.) 3s. net.

Malnutrition and Maternal Mortality

SINCE 1934, the National Birthday Trust Fund has been engaged in an attempt to reduce the high maternal mortality rates which prevail in most of the 'special areas', and some interesting results have been obtained in the last two years. A general outline of the schemes which have been applied in Glamorgan, Monmouth and Durham and the results obtained are described by Lady Williams in *Public Health* (**50**, 231, and **51**, 59; 1937).

The schemes involved additional medical facilities with or without a distribution of free foodstuffs to necessitous mothers. The additional food comprised one pint of milk daily (from the local authority) with Ovaltine and Marmite from the National Birthday Trust Fund, and either Brandox Essence of Beef or Dorsella dried milk. Analysis of the results shows that whereas increased medical facilities alone produced a definite reduction in the puerperal death-rate—to about one third—from 'other causes', the death-rate from 'sepsis' was less affected. On the other hand, in the groups receiving the extra food a remarkable reduction in the puerperal death-rate from 'sepsis' was observed.

In two and a half years, extra food was supplied to 10,384 expectant mothers: the puerperal death-rate per 1,000 total births was 1·63, being 0·09 from sepsis and 1·54 from other causes. Among 18,854 other cases in the same areas during this period, the puerperal death-rate has been 6·15, being 2·91 from sepsis and 3·24 from other causes. In the preceding seven years, the rate in these districts was 5·63. In the first six months of this year the still-birth and neo-natal death-rate among the assisted mothers has been approximately half that among cases in the same areas that were not assisted with extra food.

The evidence adduced by Lady Williams suggests strongly that it is the extra food which is responsible for the reduction in the mortality rates: the constituent or constituents have yet to be determined. Since the beef essence and dried milk were not given in all areas, and yet in all areas, among mothers assisted with extra food, the reduction in the mortality rates was observed it appears that the good results must be attributed to the milk, Ovaltine or Marmite.

It is considered that the amount of extra food given was not sufficient, in all probability, to make the diet of the poorest group of mothers who were assisted, more than equal in *quantity* to that of the better-off groups, which did not receive the extra food and acted as controls to the first group. The additional medical facilities, where provided, were available to all groups without regard to income.

It appears, therefore, that the reduction in the maternal mortality rates must probably be due to the *quality* of the extra foods supplied, rather than their *quantity*. The administration of the schemes has now been handed over by the National Birthday Trust Fund to the Research Committee of the Joint Council of Midwifery, by whom further reports will be issued when the results are available.

University Events

CAMBRIDGE.—The Rockefeller Foundation is providing the University with up to £8,000 towards the support of research in the Department of Experimental Medicine over the five-year period, January 1, 1938–December 31, 1942. The funds will be used for the salaries of a pathologist and a psychiatrist, and for supplementing the amount which the radiologist receives from Addenbrooke's Hospital.

N. F. M. Henny, of St. John's College, has been appointed University demonstrator in mineralogy and petrology.

Dr. A. H. Evans has offered to the University his collection of birds' eggs, of which the Director of the Museum writes: "This collection is practically a complete series of the eggs of British birds, and Dr. Evans has spent much time over many years in perfecting it."

The Michael Perkins Prize is awarded to I. L. Mason, of Pembroke College, for his essay entitled "Hot-spring Animals and their Adaptation to Supernormal Temperatures".

M. C. Burkitt, of Trinity College, T. T. Paterson, of Trinity College, and Dr. E. J. Lindgren, of Newnham College, have been appointed delegates to the Second International Congress of Anthropological and Ethnological Sciences, to be held in Copenhagen on August 1–6.

The Board of Management of the Frank Edward Elmore Fund will shortly proceed to the award of a studentship for research in medicine. The studentships are open to male graduates of any university who were born in any country within the British Empire other than Scotland. The student appointed will work in the Department of Medicine in the University, under the direction of the regius professor of physic. The commencing salary will be £300 a year, and the appointment will be for two years in the first instance. Further information may be obtained from the Regius Professor of Physic, Department of Medicine, University of Cambridge, to whom applications should be sent not later than February 28, 1938.

LONDON.—The title of reader in entomology in the University has been conferred on Dr. O. W. Richards, in respect of his post held at the Imperial College—Royal College of Science.

The following doctorates have been conferred: D.Sc. (Economics) on S. J. Madge, an internal student, of the London School of Economics; D.Sc. in botany on F. T. Bennett, an external student; D.Sc. in physics on C. E. Wynn-Williams, an external student.

Science News a Century Ago

The Royal Astronomical Society

IN the report of the Council read at the anniversary meeting of the Royal Astronomical Society on February 9, 1838, it was stated that the printing of the observations made at the Cape of Good Hope by Henderson on the declination of the principal stars and those made by Maclear relative to the reappearance of Halley's comet after its perihelion passage, had been done at the expense of the Government, "an evidence of the encouragement which the Government was disposed to give to science when favourable opportunities presented themselves". The Government had also granted £500 towards the repetition of the Cavendish experiment for determining the density of the earth. A eulogium was passed on the conduct of the British Association for the appropriation of £1,000 towards the improvement and reduction of astronomical catalogues. The report also referred to the arrival of the astronomical and pendulum observations made by the late Lieut. Murphy, during the voyage under Colonel Chesney down the Euphrates, the reduction of which had been undertaken by Sheepshanks and Baily. In conclusion, the Council congratulated the meeting on the flourishing state of the Society and expressed a hope that the same activity and unity of action would continue to influence and pervade their future proceedings. The president at this time was Francis Baily.

Structure of Shells

ON February 9, 1838, John Edward Gray (1800–75) assistant zoological keeper at the British Museum, lectured at the Royal Institution on "The Development, Growth and Structure of Shells". In the course of his lecture he said that the most simple form of crystalline structure is shown in the *Pinnæ* and a few other shells, where the calcareous particles, as they are deposited on the inner surface of the shell, assume a prismatic crystalline form, the crystals being perpendicular to the surface of the shell and extending from surface to surface, except where they are interrupted by any temporary suspensions of the growth of the animal. The most common form of crystalline structure which is found in most univalve shells is far more complicated, and exhibits one of the most beautiful examples of the extremely simple means by which Nature provides for the protection of her creatures. If man, he said, had but observed the process pursued by Nature in the formation of these shells, she would have taught him hundreds of years ago to combine strength with buoyancy in the perfection of naval architecture, instead of leaving it to be a modern discovery. Shells of this structure are formed of three concentric coats closely adhering together.

Biot's Experiments on Tartaric Acid

"M. BIOT has been making some important experiments and observations concerning the effect produced in rays of polarized light by different solutions of tartaric acid, either purely aqueous or combined with other bodies, which combinations alter the rays. The object of these experiments is to establish the laws of each combination, and the learned professor is still devoting his attention to the subject, in the hope of completing the system." (*Athenæum*, Feb. 10, 1838.)

Societies and Academies

London

The Royal Society, January 27.

E. GLÜCKAUF and F. A. PANETH: Identification and measurement of helium formed in beryllium by gamma rays. While it has been known for some time that the beryllium nucleus, irradiated by γ-rays, emits neutrons, it could not be decided whether the nucleus is thereby transformed into a stable isotope of beryllium of mass eight, or into two helium atoms. By a micro-chemical method, helium was detected in beryllium after irradiation by the γ-rays of radon. In one of the experiments, the number of neutrons simultaneously emitted during the irradiation was determined by measuring the helium produced by these neutrons in methyl borate; a comparison of the two helium quantities showed that the main final product of the γ-irradiation of beryllium is helium and not the beryllium isotope.

J. W. J. FAY, E. GLÜCKAUF and F. A. PANETH: Occurrence of helium in beryls. Various specimens of old beryllium metal have been analysed for helium. As the method employed, in spite of its sensitivity, failed to detect any traces of helium, it must be concluded that the spontaneous production of helium in beryllium is less than $1{\cdot}3 \times 10^{-11}$ c.c. of helium per gram beryllium per year. From this figure it follows that the helium content of beryls cannot be explained as a consequence of the spontaneous disintegration of a beryllium isotope of mass eight. In recent years, the helium content of beryls has been attributed to the influence of γ-rays from radioactive minerals in the neighbourhood of the beryls, and to cosmic radiation. From the figures, however, of the preceding paper about the amount of helium produced in beryllium by γ-rays, it follows that the influence of the natural sources of γ-radiation is not nearly sufficient to explain the helium content of beryls. Since, therefore, beryllium does not produce adequate amounts of helium, either under the influence of external radiation or as a consequence of spontaneous disintegration, it seems that the helium content of beryl is not connected with its beryllium content but is due to some other chemical element.

Moscow

Academy of Sciences (*C.R.*, 17, No. 3, 1937).

V. GANTMAKHER and V. ŠMULJAN: The linear spaces having a feebly compact unitary sphere.

V. ANTONOV-ROMANOVSKIJ: Quantitative data on the decrease of phosphorescence of Zn-phosphorus at different temperatures.

F. S. BARYŠANSKAJA: Studies on fluorescence in a layer of a thickness comparable to the wave-length.

L. I. BELJAJEV: Colloidal formations and electrophoretic phenomena on metals.

L. V. NIKITIN: The electro-chemical method of the study of mechanical deformation of metals.

M. A. ILJINSKIJ and E. S. POKROVSKAJA: The oxidation of anthracene and methylanthracene by chromic acid and by diluted nitric acid.

M. A. ILJINSKIJ and P. B. ROŠAL: (1) Determination of carbazole by way of methylol-derivate. (2) Determination of phenanthrene.

J. V. GREČNYJ: Composition and nature of organic substances from gas-bearing clays of the Melitopol territory.

O. S. VIALOV: The palæogene of the Tadjik depression.

B. A. RUBIN and E. V. ARCIKHOVSKAJA: Relation between oxidation and hydrolysis in a living cell.

F. V. ČIRIKOV: Availability of soil phosphates for the plant.

R. KH. TURECKAJA: Influence of heteroauxin on root formation in perennial plants.

A. A. ISAKOVA: (1) A study of the effect of microbial bacteriorhizal complexes on root formation in different plants. (2) Effect of bacteriorhizal complexes on the development of the sugar beet.

A. A. MIRZAJAN: Digestion stages in *Phlebotomus papatasii* Scop.

A. A. VOITKEVIČ: Morphogenetic activity of different parts of the hypophysis. (8) The influence of the anterior lobes of the hypophysis on the thyroid and the formation of feathers in pigeons.

Vienna

Academy of Sciences, December 2.

ELISABETH M. PRZIBRAM: Spot method for the macroscopic analysis of very small quantities of liquid. The liquid to be tested is sucked up by a cotton thread. This is then dabbed on a paper which has been treated by a reagent and dried. Many tests can be made with the liquid in a single thread.

A. STIFT: Transformation of dysplastically and heteroplastically transplanted hollow bones in amphibians (*Molge cristata* Laur., *Salamandra maculosa* L. and *Rana esculenta* L.).

A. STOCK: Homœosis and speed of regeneration in *Dixippus morosus* Br. et Redt. and in other insects.

K. TZONIS: Electro-meta-narcosis of fish. The duration of the period of paralysis following the passage of a current through the fish is determined for different species.

E. ZEIF: Role of the organs of sight and touch and of the blood stream in the colour changes of the tree frog (*Hyla arborea* L.).

K. GRAFF: Visual colour excesses of bright stars in the region of Cassiopeia.

E. WEGEMANN: Solubility of radium emanation in fats. Data are given for vacuum greases and for animal fats.

G. HEINRICH: Occurrence of discontinuities in the flow of liquids in tubes. There is a discontinuity in the pressure gradient along the outflow pipe of a water-jet pump. This occurs where the jet suddenly expands to fill the whole width of the tube. The stability of the discontinuity is examined theoretically.

O. PESTA: Ponds in the Kelch Alp region at Kitzbühel in the Tyrol.

A. ZAHORKA and K. WEIMANN: Velocity of hydrolysis of vinyl ethyl ether.

E. ABEL and F. FABIAN: Kinetics of halogenate-halide reactions in heavy water.

December 9.

HERTHA PERTZ: Radioactivity of thermal spring waters.

W. FLEISCHMANN and SUSANNE KANN: Test for thyreotropic hormone. The action of thyreotropic hormone on the thyroid gland of the guinea pig is made clearer by injecting colchicine.

K. ZALESKY: A new sub-species of *Sorex araneus* L. from the Dutch island of Terschelling in the North Sea.

Forthcoming Events

Monday, February 7

SOCIETY OF ENGINEERS (in the rooms of the Geological Society, Burlington House, W.1), at 6.—H. Bentham: Presidential Address.

Wednesday, February 9

ROYAL SOCIETY OF ARTS, at 8.15.—J. Roberts: "The Search for Oil".

Thursday, February 10

ROYAL SOCIETY, at 4.30.—Sir Joseph Barcroft, F.R.S., and D. H. Barron: Film illustrating "The Development of Movement in the Fœtus of the Sheep."

Friday, February 11

ASSOCIATION OF APPLIED BIOLOGISTS (in the Metallurgical Theatre, Royal School of Mines, South Kensington, S.W.5), at 2.30.—Annual General Meeting.

Dr. J. Henderson Smith: "Some Recent Developments in Virus Research".

ROYAL INSTITUTION, at 9.—The Most Rev. William Temple: "Truth in Science, Poetry and Religion".

Appointments Vacant

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:

ENGINEER (grade II) in the Station Design and Installation Department of the B.B.C.—The Engineering Establishment Officer, Broadcasting House, Portland Place, W.1 (February 7).

SCIENTIFIC OFFICER (ref. C.3—radio and line communication), JUNIOR SCIENTIFIC OFFICERS (ref. C.4—physics, electrical engineering or mathematics), ASSISTANT (grade I, ref. C.5—physics or electrical engineering), ASSISTANT (grade II, ref. C.6—physics or electrical engineering), ASSISTANT (grade III, ref. 7—physics or engineering), at the Bawdsey Research Station, Woodbridge, Suffolk—The Superintendent, Bawdsey Research Station, Bawdsey Manor, Woodbridge, Suffolk (February 12).

ASSISTANT LECTURER IN CHEMISTRY (organic) in University College, Southampton—The Registrar (February 19).

UNIVERSITY READER IN EMBRYOLOGY in University College, London—The Academic Registrar, University of London, W.C.1 (March 4).

AGRICULTURAL CHEMIST in the Tea Scientific Department, Deverashola P.O., Nilgiris—The Secretary, South Indian Association in London, 29 Mincing Lane, E.C.3.

Reports and other Publications

(not included in the monthly Books Supplement)

Great Britain and Ireland

Thirty-fifth Annual Report, 1936–1937, of the Imperial Cancer Research Fund. Pp. 48. (London: Imperial Cancer Research Fund.) [61

Technical Publications of the International Tin Research and Development Council. Series A, No. 67: Some Differences between the Structure of Electro-deposited and Hot-dipped Metal Coatings. By D. J. Macnaughtan. Pp. 16+6 plates. Free. Series A, No. 68: The Influence of the Difference of Orientation of Two Crystals on the Mechanical Effect of their Boundary. By Dr. Bruce Chalmers. Pp. 10. Free. Series A, No. 69: The Colorimetric Determination of Tin by means of Toluene-3:4-dithiol ("Dithiol"). By Dr. R. E. D. Clark. Pp. 6. Free. (London: International Tin Research and Development Council.) [61

Eleventh Annual Report, 1st August 1936 to 30th September 1937 (Accounts for the Year ending 31st July, 1937) of ULAWS. Pp. 40+xvi+4 plates. (London: University of London Animal Welfare Society.) [61

Leeds University: Department of Pathology and Bacteriology. Annual Report, by Prof. Matthew J. Stewart and Prof. J. W. McLeod; with Abstract Report on Experimental Pathology and Cancer Research, by Prof. R. D. Passey. Pp. 14. (Leeds: The University.) [61

Eighth Annual Reports of the National Radium Trust and Radium Commission 1936–1937, including a Statistical Report. (Cmd. 5612.) Pp. 80. (London: H.M. Stationery Office.) 1*s.* 3*d.* net. [61

Department of Scientific and Industrial Research. Forest Products Research Records, No. 22 (Woodworking Series, No. 1): Circular Saws. By P. Harris. Pp. 15+9 plates. (London: H.M. Stationery Office.) 6*d.* net. [61

Department of Scientific and Industrial Research: Food Investigation. Leaflet No. 7: The Conditioning of Imported Plums and Pears. By Dr. J. Barker and C. R. Furlong. Pp. 9. (London: H.M. Stationery Office.) Free. [61

Other Countries

New Zealand: Marine Department. Fisheries Bulletin No. 9: Natural Reproduction of Quinnat Salmon, Brown and Rainbow Trout in certain New Zealand Waters. By Derisley F. Hobbs. Pp. 104. (Wellington: Government Printer.) [61

New Zealand. Eleventh Annual Report of the Department of Scientific and Industrial Research. Pp. 147. (Wellington: Government Printer.) [61

Indian Science Congress Association, Silver Jubilee Session, 1938. An Outline of the Field Sciences of India. Edited by Dr. Sunder Lal Hora. Pp. v+168+17 plates. (Calcutta: Indian Science Congress Association.) [61

Crohamhurst Observatory. Paper 7: The Climate of Australia during the Hypothetical Jovian Sunspot Cycles 1877–1901, together with the Monthly and Annual Rainfall Observations at selected Stations during the Period, and some Comments on the Evidences of Cyclical Reproduction of the Weather. By Inigo Jones. Pp. 122. (Brisbane: Government Printer.) [61

Department of Agriculture, Straits Settlements and Federated Malay States. General Series, No. 28: The Practical Aspects of Copra Deterioration. By F. C. Cooke. Pp. iii+49+3 plates. (Kuala Lumpur: Department of Agriculture.) 50 cents. [61

Indian Central Cotton Committee. Annual Report of the Director, Technological Laboratory, for the Year ending 31st May 1937. Pp. 38. (Bombay: Indian Central Cotton Committee.) 6 annas. [61

Report on the Work of the Imperial Council of Agricultural Research in applying Science to Crop Production in India. By Sir John Russell. Pp. v+235+18 plates. (Delhi: Manager of Publications.) [61

Carnegie Institution of Washington. Annual Report of the Director of the Department of Terrestrial Magnetism. (Reprinted from Year Book No. 36, for the Year 1936–1937.) Pp. ii+62. (Washington, D.C.: Carnegie Institution.) [61

Royal Agricultural Society, Egypt. Technical Section, Bulletin No. 33: Long Staple Cottons in Egypt; a Survey of the Present Position and a Proposal for the Future. By Dr. M. A. Fikry. Pp. 14. (Cairo: Royal Agricultural Society.) [61

Report of the Aeronautical Research Institute, Tôkyô Imperial University. No. 157: Experimental Research on the Temper-hardening of the Silver-rich Ag-Al Alloys. By Shiro Ishida, Hideo Tajiri and Masao Karasawa. Pp. 77–114. (Tôkyô: Kôgyô Tosho Kabushiki Kaisha.) 55 sen. [61

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 84: The Basal (Standard) Metabolism of the Australian Merino Sheep, 2. By A. W. Pierce. Pp. 22. Bulletin No. 110: Radio Research Board Report No. 12. Pp. 46. Bulletin No. 111: Radio Research Board Report No. 13. Pp. 59. (Melbourne: Government Printer.) [61

Tide Tables for the Atlantic Coast of Canada for the Year 1938: including the River and Gulf of St. Lawrence, the Bay of Fundy, Northumberland and Cabot Straits, Hudson Bay; and Information on Currents; in addition Tide Tables for New York and Boston, U.S.A. Pp. 98. (Ottawa: Department of Mines and Resources.) [61

Proceedings of the United States National Museum. Vol. 85, No. 3027: On some Onychophores from the West Indies and Central America. By Austin H. Clark. Pp. 4. (Washington, D.C.: Government Printing Office.) [61

Department of Science and Agriculture, Jamaica. Bulletin No. 3: Field Experiments on Sugar Cane in Jamaica, 1933–1936. Report by H. H. Croucher. Pp. 13. Bulletin No. 10: Progress Report on Damage done in the Kingston and St. Andrew Area by Termites which infest Buildings. Pp. 11. Bulletin No. 12: Reprints of Miscellaneous Articles, 1936. Pp. 31. (Jamaica: Government Printing Office.) [61

U.S. Department of Agriculture. Leaflet No. 144: Cockroaches and their Control. By E. A. Back. Pp. 6. 5 cents. Leaflet No. 147: House Ants. By E. A. Back. Pp. 8. 5 cents. (Washington, D.C.: Government Printing Office.) [61

U.S. Department of the Interior: Office of Education. Bulletin, 1937, No. 6: Bibliography of Research Studies in Education, 1935–1936. Prepared by Ruth A. Gray. Pp. xiv+338. 30 cents. Pamphlet No. 80: Sources of Visual Aids and Equipment for Instructional Use in Schools. Compiled by Cline M. Koon. Pp. iii+44. 10 cents. (Washington, D.C.: Government Printing Office.) [61

Pennsylvania State College: School of Agriculture and Experiment Station. Bulletin 339: The Digestibility of Rations by Cattle and Sheep. By Ernest B. Forbes, John W. Bratzler, Alex Black and Winfred W. Braman. Pp. 30. (State College, Pa.: Pennsylvania State College.) [61

Catalogues, etc.

B.D.H. Vaccines and Sera. Pp. 60. (London: The British Drug Houses, Ltd.)

Determination of Moisture. (Circular No. 332.) Pp. 2. (London: A. Gallenkamp and Co., Ltd.)

Precision Gauge for Measuring Liquid in Tanks. (List No. G/23.) Pp. 8. (London: Negretti and Zambra.)

Musik: Praktisch, historisch, theoretisch. Teil 1: A—Fetis. (Antiquariats-Katalog Nr. 51.) Pp. 112. (Leipzig: Karl Max Poppe.)

Old Science and Medicine. (List 27.) Pp. 38. (London: E. P. Goldschmidt and Co., Ltd.)

Concentration Recorder Controller. (List No. R/9.) Pp. 8. (London: Negretti and Zambra.)

Quartz Spectrograph and Visual Ultra-Violet Absorptiometer (FA 37.) Pp. 8. Photographic Recording. (REG 37.) Pp. 4. (Delft: P. J. Kipp en Zonen.)

Le Officine Galileo nell'Anno II dell'Impero, Anno XV E.F. MCMXXXVII. Pp. 124. (Firenze: Le Officine Galileo.)